# Association of American State Geologists
## 2013–2014 Officers

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<td>John Parrish</td>
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AASG was founded in 1908 when President Theodore Roosevelt called together Federal and State agencies to launch the natural resources conservation movement. The States were represented by governors and state geologists. The AASG was formally created to assist in promoting Federal and State programs and assist in the further success of state geological surveys. The AASG has been going strong for 106 years, and from the successful events of 2013–2014 it looks as if our organization is well on its way to another century of service to our respective states and their citizens.

It has been a wonderful honor to serve as the AASG’s President for the 2013–2014 business year—and I express my very deep appreciation to those on the Executive Committee who were most responsible for running a smooth organization: Past-President Harvey Thorleifson; President-Elect Jon Arthur; Vice President Joe Gillman; Secretary David Spears; and, Treasurer Michael Hohn.

BUSINESS MEETINGS

Denver was the host city for the AASG 2013 Mid-Year Meeting (October 29th), with 26 State Geologists in attendance. Topics of discussion were: a recap of the very successful 2013 Annual Meeting in Deadwood, South Dakota; preparations for the upcoming 2014 Annual Meeting in Lexington, Kentucky; plans for the 2015 Annual Meeting in Flagstaff, Arizona; and setting future locations for the next annual meetings (2016 Fairbanks, Alaska; 2017 Branson, Missouri; 2018 Delaware; 2019 Montana). Also discussions were started on several areas of the AASG’s By-Laws, including the definition of a “State Geologist” and who sits as a representative to AASG; on the assignment of duties and responsibilities of members of the Executive Committee, terms of office; and, annual fees.

The 2013 Fall Liaison Meeting in Washington, D. C. (September 2013) was conducted by 14 AASG representatives who participated in three days of business meetings with 28 agencies and organizations.

Spring Liaison Meeting 2014 in Washington, D. C. was nearly shut down on its opening day of business when a snow storm abruptly “closed” the city. Fortunately, representatives from the USGS and AGI were able to creatively modify their schedules and successful meetings were conducted with the USGS at the Cosmos Club in the morning and at AGI in the private home of one of its executives during the afternoon. In all, 17 AASG representatives conducted business with 28 agencies and organizations.

Topics for both the Fall 2013 and Spring 2014 meetings ranged through the NGGDPP, NCGMP-StateMap, National Groundwater Monitoring Network, data initiatives, national LiDAR, minerals, climate science and hydraulic fracturing, and AASG structural organization.

The Annual Pick and Gavel Awards Banquet was held at the Cosmos Club and attended by about 76 guests from various agencies and organizations, including 19 AASG members. This year’s Award went to Congressman Ken Calvert from the 42nd District of California.

The Kentucky Geological Survey under the able leadership of State Geologist Jim Cobb, hosted the 2014 Annual Meeting in the beautiful environs about Lexington. The Meeting featured a wonderful array of field trips, plenary and breakout sessions, and a Banquet special guest speaker, world renowned author Simon Winchester. About 107 guests attended the meeting, including 35 state geologists.

ANNUAL AWARDS

It was a most fitting tribute that former California State Geologist Dr. James F. Davis was awarded the Ian Campbell Medal for Superlative Service to the Geosciences. Ian Campbell was a former California State Geologist and James Davis and Ian were working acquaintances.

Also of noteworthiness was the recognition of Dr. Peter A. Scholle, former New Mexico State Geologist, for the AASG Distinguished Service Award.

This year’s Charles J. Mankin Memorial Award went to authors H. Scott Hamlin and Robert W. Baumgardner of the Texas Bureau of Economic Geology, for their publication Wolfberry Deep-Water Depositional Systems in the Midland Basin: Stratigraphy, Lithofacies, Reservoirs, and Source Rocks.

The John C. Frye Environmental Geology Award was presented to The Groundwater Atlas of Nebraska; Resource Atlas No.4b/2013.

OTHER ACCOMPLISHMENTS AND BUSINESS

As many are aware, the expanding good fortunes of the United States Geothermal Information Network (USGIN) and the National Geothermal Data System (NGDS), which have been single-handedly guided by Arizona State Geologist Lee Allison, have achieved an independent national status of their own as a recognized versatile data base system. The database system will become the property of AASG, to be managed by an AASG board of directors to be established in 2014–2015. Significantly in early 2014, the NGDS was recognized as the only operational system that meets all of the requirements of the White House Executive Order for the Open Data Access Initiative.

Earlier in 2014, also through the good services of Lee Allison, AASG became a signatory member of the international OneGeology. AASG has become recognized internationally as an important and influential geological organization. The NGDS concept, also, has been adopted by the 117-nation OneGeology consortium as basis for a “virtual global geological survey”, providing access to all geoscience data worldwide.

AASG has been working closely with the American Geosciences Institute (AGI) to expand this relationship and develop more effective and productive ways to bring the teaching of Geology into the elementary and high schools; to improve our policies in Washington, D. C., and to broaden our contacts with other geoscience organizations.

At the Lexington 106th Annual Meeting, AASG signed an updated Memorandum of Agreement (MOA) with the USGS, thereby signaling the continued purposeful working relationship between our two great organizations that began over a century ago. Also signed at the meeting was an MOA with the National Aeronautics and Space Administration (NASA).

AASG Water Committee Chairman David Wunsch, State Geologist from Delaware, received a letter of appointment from Secretary of the Interior Sally Jewell appointing him for another term as AASG’s representative to the federal Advisory Programs Council (FAPC).
Committee on Water Information (ACWI). He continues to represent AASG on the ACWI Subcommittee on Ground Water in their effort to build a National Ground Water Monitoring Network.

The National Geologic Map Database (NGMDB) continues to support the role of state geological surveys. The content for the NGMDB Map Catalog, Geolex, and geologic map viewer were built through collaboration with each state survey. The NGMDB continue to coordinate development of standards and guidelines through collaboration with state surveys.

Harvey Thorleifson, State Geologist for Minnesota, represented AASG on the National Geospatial Advisory Committee. Priorities included strategic plans for the National Spatial Data Infrastructure, Landsat, geolocation privacy, national address database, and OMB Circular A-16 which defines federal roles in geospatial data.

3DEP continues to be a USGS focus. In December 2013 Jay Parrish, former State Geologist from Pennsylvania and AASG Honorary Member, testified in support of the USGS effort on behalf of AASG at a hearing of the Congressional Subcommittee on Energy and Mineral Resources.

AASG is working with the USGS on a new National Landslide Program as a direct result of the devastating Oso Landslide (Washington State) and the Mesa County, Colorado landslides. AASG also continues to work with federal agencies and Congressional staffs in joint efforts to have the National Earthquake Hazard Reduction Program (NEHRP) reauthorized, as well as the Tsunami Warning and Education Act or 2006 (TWEA) reauthorized.

**ON THE HORIZON**

Even though there are many achievements started and completed during this and every previous year, AASG faces both continuing and new issues to address to successfully surmount it is to continue as a dynamic and influential organization. A few of those are:

We must continue to develop the geology curricula at the pre-university levels, and to push for educational programs in every state.

The future and influence of the AASG as a representative of the States’ interests can only be achieved by active participation of the membership—it is not always easy to split one’s roles and responsibilities between home state survey service and volunteered service to a national organization, but AASG is unique in its origin, membership, and purpose—and it deserves the full and forceful support of its members.

State surveys face the need to replace about eight or nine vacant and soon to be vacant State Geologist positions in the next two years. AASG must take the initiative in finding and nurturing individuals to replace those State Geologists who are retiring—we must go all out to find creative and qualified professionals to replace those who leave the ranks.

AASG currently faces a dissolution of some state surveys. AASG must continue to encourage and champion the maintenance of strong and relevant state geological surveys. We must not become complacent or tolerant as we watch state surveys vanish.

Funding to support AASG is always an issue, and it likely always will be. Nevertheless, the AASG must recognize that eventually it will need to increase its annual fees in order to maintain its existence, its activities, and its Mission.

It has been my honor to serve as the President of this great organization and to work with so many talented, resourceful and creative individuals. Your incoming President and Executive Committee are an exceptionally gifted and talented group, and AASG will be in very good hands. I urge you to give your full and loyal support to them.

Cheers—

[signature]
ALABAMA

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The Geological Survey of Alabama (GSA) is an independent state agency that reports to the Alabama Legislature and the Governor. The GSA's mandate is to survey and investigate the mineral, energy, water, coastal, and biological resources of the state, to maintain adequate geologic, topographic, hydrologic, and biologic databases, and to prepare maps and reports on the state's natural resources to encourage the safe and prudent development of Alabama's natural resources while providing for the safety, health, and well-being of all Alabamians. The State Geologist is Director of the GSA and, by virtue of the position, is also the Oil and Gas Supervisor (i.e., director) of the State Oil and Gas Board of Alabama (OGB). The OGB is the state's regulatory agency for all oil and gas exploration, production, and development.

The State Geologist serves as the Governor's representative to the Interstate Oil and Gas Compact Commission and holds an appointment to the National Petroleum Council. He is currently President of the American Geosciences Institute (AGI). Within the State of Alabama, the State Geologist serves as chairman of the Alabama Water Agencies Working Group, serves as an Alabama Natural Resources Trustee and an ex officio member of the Alabama Permanent Oil and Gas Study Committee, serves as a member of several committees including the Joint Legislative Permanent Committee on Energy Policy, the Joint Legislative Committee on Water Policy and Management, the Water Resources Council, the Coastal Resources Advisory Committee, the Coastal Area Erosion Task Force, the Alabama League of Municipalities Energy, Environment and Natural Resources Committee, the University of Alabama Museums Board of Regents, and the University of Alabama Department of Geological Sciences Advisory Board.

GSA programs include investigations of the mineral, energy, water, coastal, and biological resources of the state to determine their quality, character, capacity for development, and environmental significance. The GSA collects, analyzes, and transfers resource data, databases, and scientific reports to state and federal agencies upon which sound regulatory and other decisions can be made, to industries interested in mineral and energy resource development, and to Alabama's citizenry. The GSA maintains and makes available comprehensive databases for the mineral, energy, water, coastal, and biological resources of the state. The GSA is involved in public education and outreach through its Adopt-A-School partnership with local schools and through an in-house speaker's bureau that provides speakers for various educational venues such as teacher institutes, at Earth Day and Earth Science Week celebrations, and at schools around the state.

GSA continues to enhance its website. The website serves both the GSA and its sister agency the State Oil and Gas Board. Major program initiatives include several new projects with the cooperation of federal and state agencies.

ENERGY INVESTIGATIONS

The Energy Investigations Program, made up of two sections, Coal Systems and Technology and Petroleum Systems and Technology, performs basic and applied research on Alabama's diverse energy resources, which include conventional oil and gas, coalbed methane, oil sand, shale gas, and coal.

Coal research includes characterization of coal resources under the auspices of the U.S. Geological Survey's National Coal Resources Data System (NCRDS). Work under NCRDS includes the compilation of basic coal resource data from more than 7,000 coalbed methane wells and exploratory cores, which have been drilled in the eastern part of the Black Warrior Basin. In addition, program scientists are developing an integrated database and Geographic Information System of underground coal mines in the Black Warrior Basin with the support of the U.S. Department of the Interior's Office of Surface Mining.

A study of produced water and gas from coalbed methane reservoirs in the Black Warrior basin was completed that was funded by the National Energy Technology Laboratory of the U.S. Department of Energy. This study used water chemistry, gas chemistry, and basin hydrology as criteria for understanding reservoir dynamics and the available options for produced water management. Results indicate that complex interconnections exist among water quality, hydraulic yield, and the quantity and producibility of natural gas that must be considered when evaluating options for the disposal and beneficial use of produced water.

The GSA is part of the Southeastern Regional Carbon Sequestration Partnership (SECARB) technology coalition, and with the support of the U.S. Department of Energy, the Southern States Energy Board, Virginia Tech, Southern Company, and the Electric Power Research Institute, the Energy Investigations Program has been involved in numerous carbon sequestration projects. For example, program personnel have been working on geological characterization and modeling related to injection of CO2 into unconventional storage reservoirs in the central Appalachian Basin. Additionally, a pilot test determining the potential for CO2-enhanced oil recovery in Citronelle Field, which has produced nearly 170 million barrels from Lower Cretaceous sandstone, was recently completed.

Work on the second phase of the Energy Investigations Program's involvement with the Research Partnership to Secure Energy for America (RPSEA) continues, focusing on the petrology of gas shales within the state. The goals of the project are to improve understanding of rock-fluid interactions in shale, to improve petrophysical characterization methods, and to develop methodology for the selection of fracturing fluids and additives. With the renewed interest in expanding energy resource development within the United States, the Alabama Oil Sands Program (AOSP) was established. The AOSP is charged with providing a roadmap to facilitate prudent commercial development; assisting in the realization of economic and societal benefits from prudent, orderly, and environmentally sound development; providing focus for oil sands activities and initiatives; and developing and implementing appropriate legal and regulatory frameworks. As part of the AOSP, the Energy Investigations Program has begun a systematic, scientific assessment of Alabama's oil sands. The project will include core drilling, core analyses, petrologic studies, and evaluation of extraction technologies. The Energy Investigations Program has completed the Geological Survey of Alabama's initial contribution to the National Geo-thermal Data System (NGDS). This ARRA-funded project was
managed by the Arizona Geological Survey for the Association of American State Geologists (AASG). The goal of the project was to ensure access to at-risk, legacy, geothermal-relevant data and publications. Program scientists have provided the data in interoperable formats, resulting in over 54,000 records being made available from the state through the NGDS portal at http://geothermaldata.org.

Other projects undertaken by the Energy Investigations Program include a preliminary assessment of compressed air energy storage within the state undertaken for Southern Company Services; data rescue efforts in cooperation with the Federation for Earth Science Information Partners; and discrete fracture network modeling to support underground injection fluid migration modeling.

**GEOLOGIC INVESTIGATIONS**

The Geologic Investigations program conducts basic geologic and coastal research, monitors and investigates geologic hazards, and directs the geologic mapping program. It also maintains and manages the core and well sample warehouse and sample viewing facility, the paleontology collection, the library, and the Publications Office, and publishes GSA and OGB reports. The Program includes three sections: Geologic Mapping and Hazards, Coastal Resources, and Resources Information.

The Geologic Mapping and Hazards group participates in the STATEMAP component of the National Cooperative Geologic Mapping Program, which is administered by the U.S. Geological Survey. Supported through the program, geologic mapping of the Eulaton, Ochatchee, and Wellington 7.5-minute quadrangles was completed, and mapping of the Hyatt Gap and Steele quadrangles was initiated. The section also assisted Auburn University, the University of South Alabama, and Florida State University with proposals to the EDMAP component of the National Cooperative Geologic Mapping Program.

Hazard-related activities include monitoring the geologic hazards of the state, statewide mapping of geologic hazards in a GIS format, investigating the causes of geohazards in Alabama, answering a wide range of information requests on geohazards, and promoting public awareness of the potential dangers of geohazards. The section also cooperates with other organizations that mitigate damage from geohazards in our region and contributes to the State Hazard Mitigation Plan as well as the Threat and Hazard Identification and Risk Assessment plan newly required by Homeland Security. In addition, the Hazards director and the State Geologist continue to be involved with state GIS planning and coordination by serving on the Alabama GIS Advisory Board and Executive GIS Council as Government-appointed members.

In cooperation with the Alabama Emergency Management Agency with funding through the National Earthquake Hazard Reduction Plan, the Hazards group completed a project using HAZUS software to examine potential damage in northern Alabama from a potential large-magnitude East Tennessee Seismic Zone (ETSZ) earthquake as well as to assess interest in creating a multi-state/multi-agency ETSZ planning and research group. Because the Hazards director also manages the GSA Paleontology Collection, Hazards staff also continued to prepare metadata describing Cenozoic fossils in the Collection for submission to the National Catalog maintained by the National Geologic and Geophysical Data Preservation Program.

The Coastal Resources Section conducts land- and marine-based research within Alabama's coastal counties to increase our understanding of beach and shoreline change, environmental quality, and land use and to facilitate the acquisition and development of supporting digital themes and datasets. This section also provides GIS support of strategic disaster recovery efforts to the Alabama Emergency Management Agency in response to hurricane and tornado impacts.

Because of the importance of tourism along Alabama's beaches to the state's economy, the Gulf-fronting Shoreline Monitoring Program is conducted by GSA in cooperation with the Alabama Department of Conservation and Natural Resources (ADCNR). This program mainly includes the acquisition of beach topology and orthophotography and archiving shoreline data from external sources. In response to the Deepwater Horizon oil spill in the Gulf of Mexico in April of 2010, Coastal staff conducted independent and cooperative field investigations and data management in support of Natural Resource Damage Assessment and Restoration (NRDAR) Program interests. Through the Mobile Bay National Estuary Program and directed by ADCNR, the Coastal group continued a multi-year effort to develop the framework and inventory geospatial themes needed to support the Coastal and Marine Spatial Planning Program. The Resources Information Section comprises the Publications Office, a geological core repository, and a comprehensive earth science library. The Publications Office is the primary outlet for the more than 1,200 reports and maps that GSA has published on the state's geology and natural resources. GSA publications range in style from nontechnical works intended for educational use to detailed maps and reports summarizing the geology and resource base of specific areas to highly technical, specialized scientific monographs.

The GSA and OGB maintain a core storage repository where cores and samples from more than 10,000 oil and gas wells drilled in the state are available for study by researchers and oil and gas companies. Also, more than 450 coal and mineral exploration cores, 240 offshore sediment cores, and 2,700 samples from water wells are archived in the facility. In total, more than 67,000 boxes of core and samples are stored in the GSA/OGB warehouse. GSA is home to one of the largest earth science libraries in the southeast. The library contains over 150,000 titles including books, journals, monographs, theses and dissertations, manuscripts, open-file reports, and other publications from state and federal agencies and professional organizations, foreign publications, and maps. The Resources Information Section is also responsible for editing and publishing GSA/OGB publications. During the period from July 2013 through June 2014, GSA published 1 new report and released 7 open-file reports. Open-file reports are available through GSA's library.

**GROUNDWATER ASSESSMENT PROGRAM (GAP)**

The GAP is involved in a wide variety of hydrogeologic and geochemical assessments throughout Alabama to develop additional sources of public, industrial, and agricultural water supply, to protect current sources, and to develop basic scientific understanding of Alabama's groundwater resources for water policy development. The scope of the GAP ranges from local and regional to statewide projects. Local and regional groundwater research is performed in cooperation with local governments and water supply systems to address stratigraphic and geochemical considerations related to the occurrence and development of potential water sources. The GAP is also working with the Alabama Legislature through the Permanent Joint Legislative...
Committee on Water Policy and Management to develop a state-wide groundwater hydrogeologic assessment that will be used to develop state water policy initiatives. The GAP also performs surface-water assessments to evaluate water quality and sedimentation impacts and to assess groundwater/surface-water interaction related to runoff and recharge.

The GAP maintains a groundwater level monitoring program that involves about 400 wells monitored annually and a real-time monitoring system of 23 wells and 2 springs. This system will be expanded in the future to include more than 30 wells. These data will be available to the public through the GSA website. Data from the monitored wells are used to determine impacts of climate and water production on all major aquifers in the state. The GAP Water Information Section also receives and digitally catalogs drillers’ reports every year on new wells, in addition to collecting and filing all related groundwater records for GSA research projects. The GSA well file is the most extensive collection of water well records in the state and is currently being placed online.

The Geochemical Laboratory continued in its support role for GSA research and regulatory analytical needs and in its acquisition of baseline geochemistry of Alabama waters, soils, rocks, and streambed sediments.

An online water resource information database is currently under development with a goal of creating consistent, compatible databases, archiving legacy water data, enhancing capabilities for digital acquisition of field data, and furthering the use of the web for data and information dissemination. The GSA GAP website was upgraded during 2014 and includes various hydrogeologic data and interesting water resources information.

**ECOSYSTEMS INVESTIGATIONS**

Aquatic biodiversity studies are important not only from the standpoint of faunal inventory but also due to the fact that organisms and communities of organisms are very useful tools for monitoring stream water quality. The Ecosystems Investigation Program (EIP) has conducted scores of studies in this area including basin surveys of fishes, mussels, and aquatic invertebrates, status surveys of threatened and endangered species, and investigations of fish movements in large rivers. The EIP biologists are continuing several studies and initiating new studies. Mussel surveys in tributaries of the Black Warrior River were completed in 2013 and a comprehensive report including this mussel data and snails collected by Alabama Department of Conservation and Natural Resources Division of Wildlife and Freshwater Fisheries staff is in preparation. Monitoring the endangered Alabama Cave Shrimp and the Tuscumbia Darter on Redstone Arsenal continued for the 21st year and 14th years, respectively. Cooperative studies with the Alabama Department of Environmental Management and the Wildlife and Freshwater Fisheries Division of the ADCNR were completed recently to develop a boat electrofishing sampling protocol for use in assessing fish communities in deep, nonwadeable rivers, lakes, and streams. The EIP initiated a cooperative effort in 2008 with ADCNR and the U.S. Fish and Wildlife Service, which continued this year, to address the conservation needs of aquatic species through the collection, acquisition, and presentation of integrated aquatic resources data. These data will be used to define and characterize strategic habitat management units and provide information to local landowners, watershed organizations, and local governments to enhance conservation opportunities for species recovery and restoration. Habitat assessment and biological monitoring studies in other strategic habitat units continued for the Big Canoe Creek and Terrapin Creek watersheds in the Coosa River system, Murder Creek in the Conecuh River system, Bear Creek in the Tennessee River system, and the Sipsey River in the Tombigbee River system. A three-year State Wildlife Grant project aimed at continuing to update our knowledge of cray-fishes statewide started in late 2013 and two new state records have been secured to date. Objectives included filling collection gaps in under-sampled watersheds, ecoregions and habitats; resampling historic sites for comparison; and creating a GIS product to assist in mapping and management of the fauna. The EIP maintains voucher fish and freshwater invertebrate collections containing approximately 450,000 and 3,000 specimens, respectively. The invertebrate specimens were recently donated to Auburn University, a move that will provide more long-term and secure curation of the specimens, and plans are underway to transfer the GSA fish collection to the University of Alabama Ichthyological Collection for permanent curation as well.
Mission: Determine the potential of Alaskan land for production of metals, minerals, fuels, and geothermal resources, the locations and supplies of groundwater and construction material, and the potential for geologic hazards to buildings, roads, bridges, and other installations and structures (AS 41.08.020).

The Alaska Division of Geological & Geophysical Surveys (DGGS) is part of the Alaska Department of Natural Resources (DNR) and is organized into six program sections: Energy Resources, Mineral Resources, Engineering Geology, Volcanology, Geologic Communications, and the Alaska Geologic Materials Center. The division currently has 42 full-time permanent positions, eleven full-time temporary positions, and eleven student interns. The total FY2014 expense budget for the division was $11.05 million, consisting of $4.87 million state general fund receipts, $3.23 million state capital project funds, $1.43 million federal receipts, and $1.52 million interagency receipts, industry support, and publications sales. DGGS maintains a website at www.dggs.alaska.gov, which provides access to its publications and digital data as well as to all pre-digital USGS publications on Alaska geology. DGGS also administers websites for the Alaska Volcano Observatory www.avo.alaska.edu, the Alaska Seismic Hazards Safety Commission www.seismic.alaska.gov and the Association of American State Geologists www.stategeologists.org.

ENERGY RESOURCES

Alaska’s Statewide Energy Resource Assessment program generates new geologic information about the state’s oil, natural gas, coal, and geothermal resources and presents this information to the industry, public and state and federal agencies through formal reports and presentations. DGGS collaborates with the Alaska Division of Oil & Gas (DOG) to incorporate subsurface data in interpretations of complex depositional systems, tectonic provinces, and hydrocarbon systems analysis.

Exploration for gas in the Cook Inlet basin continues to be of high interest for the oil and gas industry due to potential deliverability shortfalls in the south-central Alaska gas market. Attention is being focused on undiscovered conventional oil and gas reservoirs and the possibility of unconventional reservoirs (such as tight gas sands, fractured reservoirs, and source-reserved oil and gas). To stimulate sustained exploration interest DGGS initiated a multiyear study of this basin in 2007, providing relevant high-quality data to help evaluate its resource potential. This project focuses on building a robust model of the basin’s stratigraphy to help predict the distribution of potential sandstone reservoirs and to provide a better understanding of parameters controlling reservoir quality and producibility. In summer 2013 DGGS conducted 250 square miles of 1:63,360-scale geologic mapping of the Iniskin Peninsula on the west side of lower Cook Inlet to better understand stratigraphic and structural characteristics of the Cook Inlet Mesozoic basin margin and potential implications for its Mesozoic petroleum system.

Over the last decade, DGGS has led field-based geologic mapping, stratigraphic, and structural studies of the central and eastern North Slope. This work has improved our understanding of the local and regional evolution of the basin and contributed to exploration interest in the Brooks Range foothills. This underexplored frontier province appears to be dominantly gas-prone and has the potential to yield additional reserves for proposed natural gas pipelines. In FY2014, DGGS published a new tectonic model for the development of the Brooks Range foothills in the peer-reviewed journal Terra Nova. We are in the process of compiling recent field mapping in the Umiat–Gubik area, and integrating this surface data with available subsurface information. DGGS is also engaged in a collaborative project with the U.S. Geological Survey and the University of Alaska Fairbanks to evaluate the geology of potential shale oil units on the North Slope. Initial fieldwork has focused on the stratigraphy and geochemistry of the prolific oil-prone Shublik Formation exposed in the eastern Brooks Range foothills; subsequent work will evaluate the organic-rich Cretaceous Hue Shale.

Numerous sedimentary basins throughout Alaska have geologic characteristics that are conducive to natural gas, including unconventional gas. However, the stratigraphy in most of these basins is so poorly known that we do not have a realistic understanding of their gas potential. We are continuing to study the natural gas potential of the Susitna basin north of Anchorage and the Nenana basin near Fairbanks. Field studies continued in 2013 in the vicinity of the Nenana basin, where interest in exploration for natural gas has increased in recent years. In FY2014, DGGS published progress reports for 2012 field studies in the Susitna, Nenana, and Tanana basins. Analysis of data from initial field studies is ongoing; information obtained from this work will add to the database of publicly available information on the petroleum geology of these basins, which will help stimulate private-sector exploration activity.

As a participant in the AASG-organized and U.S. Department of Energy-funded National Geothermal Data Systems (NGDS) project, the Statewide Energy Resource Assessment program continued its efforts in FY2014 and developed a new list of Alaska thermal springs and associated aqueous and gas chemistry, geothermal profile well data, bottom-hole temperature data from oil and gas exploration wells, and geothermal drill core descriptions. These new data are accessible online to industry and the public and will enable research and development of geothermal sites in Alaska. They are also being incorporated into a new geothermal map for Alaska that will include Quaternary and younger volcanic vents, along with active faults.

The Statewide Energy Resource Assessment program is collecting new coal quality and stratigraphic data during the ongoing geologic energy field studies and is working to implement a comprehensive statewide coal resource data file as part of an integrated DGGS geologic data management system. During FY2014, we published information on Alaska’s coal basins, evaluated coal lease applications, and continued to collect new coal-quality and stratigraphic data. Analysis of data from 2012 field studies in the vicinity of the Nenana basin, where interest in exploration for natural gas has increased in recent years, is ongoing; information obtained from this work will add to the
database of publicly available information on the petroleum geology of these basins, which will help stimulate private-sector exploration activity.

MINERAL RESOURCES
To attract mineral-exploration interest and to support responsible development of Alaska’s mineral endowment, DGGS conducts geological mapping and geochemical and geophysical surveys of the most prospective Alaska lands open for resource development. The Alaska Airborne Geophysical/Geological Mineral Inventory (AGGMI) program, funded by the state legislature, enables the Mineral Resources program to conduct these surveys.

Recognizing Strategic and Critical Minerals (SCMs) are essential for our modern, technology-based society, DGGS initiated a state-funded Rare-Earth Elements and Strategic Minerals Assessment project in 2011. This program was expanded in 2012 to a 5-year project to evaluate Alaska’s statewide potential for SCMs. The goals of this project are to: (1) compile historic and industry-donated SCM data in digital format; (2) obtain new geophysical, geochemical, field-geologic and analytical data critical for assessing Alaska’s SCM potential; (3) evaluate the historic and new data to identify areas of Alaska with the highest SCM potential, and those needing additional geologic evaluation; (4) communicate the results to the public; and (5) publish the data and results on the DGGS website.

In FY2014, DGGS completed the airborne geophysical survey for 854 square miles in the Farewell area, southcentral Alaska. DGGS contracted for a 1,400-square-mile airborne geophysical survey covering part of the Wrangellia terrane and adjacent to previous Iron Creek, Valdez Creek, and Southern Delta River airborne geophysical surveys in south-central Alaska, and for a 1,057-square-mile airborne geophysical survey in the East Styx area, extending the earlier East Styx survey in south-central Alaska. DGGS published geophysical maps and data for 238 square miles in two areas of the Farewell survey area, adjacent to the previously flown Styx River survey, and for 1,029 square miles in three areas adjacent to the previously flown Aniak and Iditarod surveys, western Alaska.

In summer 2013, DGGS conducted a 210-square-mile geologic field mapping program in the Lime Hills C-1 Quadrangle, western Alaska Range, covering part of the 2008 Styx River geophysical survey area, a region with potential for igneous-related gold and porphyry copper deposits. DGGS also conducted follow-up rock geochemical sampling and continued geologic research and strategic and critical mineral resource assessment of 3,500 square miles in the Ray Mountains-Dalton Highway area, Interior Alaska.

ENGINEERING GEOLOGY
The Engineering Geology group addresses engineering-geology and geologic-hazards issues affecting public and infrastructure safety in Alaska. DGGS conducts engineering-geologic mapping to determine the distribution and character of surficial deposits, their suitability for foundations, susceptibility to erosion, earthquakes and landslides, and other geologic hazards. Geologic evaluations of areas subject to hazards like floods, earthquakes, volcanic eruptions, tsunamis, and landslides help to forecast the likelihood of future events and the severity of hazards associated with them. DGGS has initiated a Hydrogeology program to assess Alaska’s groundwater resources and lead research efforts that focus on groundwater issues related to resource development; the program is developing a statewide water database and collecting information to begin modeling the hydrogeology of the North Slope. In FY2014, the Engineering Geology group completed and published the results of a short-fuse field project for the Alaska Department of Transportation and Public Facilities (DOT&PFF) to provide baseline geotechnical and geomorphic observations on a landslide that occurred adjacent to the Yukon River bridge along the Dalton Highway.

DGGS is actively addressing the critical need for baseline geologic mapping and natural hazards evaluations for coastal communities. Funding from the federal Coastal Impact Assistance Program, supports DGGS’s 5-year Coastal Hazards program evaluating surficial geology and geologic hazards in 19 Alaska coastal communities at risk from erosion and flooding hazards. These hazards, along with thawing permafrost and possible sea level changes, are real concerns for many Alaskan communities. DGGS is assisting with the evaluation of proposed relocation sites for communities faced with the immediate need to move to a safer location. In FY2014, geologic fieldwork was conducted in nine coastal communities in support of this program.

DGGS supplies reliable scientific information to help the state and its communities prepare for impacts from geologic hazards affected by climate change. The Climate and Cryosphere program completed the first year of a multi-year glacier change and hydrology study of the upper Susitna drainage basin as part of pre-licensing studies for the proposed Susitna-Watana Hydroelectric Project. The focus is on modeling the effects of future climate variability and change, permafrost thaw, and glacier wastage and retreat on runoff, and whether those changes will threaten the long-term viability of power generation by impacting the project’s critical resource—the Susitna River.

The DGGS Neotectonics program is dedicated to identifying and understanding active faults and earthquake hazards in developing areas of the state. The program is engaged in significant work in support of proposed infrastructure projects and contributes to community tsunami hazards studies and collaborative projects with the U.S. Geological Survey and university researchers from across the country to study and understand the fault-related hazards in Alaska. DGGS participates in the National Tsunami Hazards Mitigation Program, publishing inundation maps for communities at risk from tsunamis. Inundation maps are based on numerical modeling of multiple scenarios for distant and local sources, performed by University of Alaska Fairbanks personnel at the Arctic Region Supercomputing Center. Maps have been published for Kodiak, Homer, Seldovia, Seward, Whittier, Valdez, and Sitka, and are in progress for Chenega Bay, Cordova, and Tatitlek.

DGGS’s Corridor program continued the geologic mapping and hazards evaluation of natural gas export pipeline corridors from Prudhoe Bay to Valdez, Anchorage, and the Canada border. The purpose of this multi-year project is to provide geologic information for 12-mile-wide corridors on which to base alignment, engineering, permitting, and planning decisions. Following acquisition of high-resolution airborne geophysical data in 2006, DGGS began collecting field data. In 2010 and 2011, DGGS acquired high-resolution airborne lidar data along these corridors, totaling more than 3,000 square miles. The lidar data has enabled significant refinement of the geologic mapping between Delta Junction and the Canada border, and of potentially active faults and other hazards along the corridors. Minor 2013 field work concluded the data gathering phase of the project, and final reports and maps will be published in FY2015.
**VOLCANOLOGY**

The Volcanology program of DGGS is part of the Alaska Volcano Observatory (AVO), an interagency consortium which mitigates hazards from Alaska volcanoes. AVO was formed by Memorandum of Understanding in 1988. Its partners are DGGS, the U.S. Geological Survey (USGS), and the University of Alaska Fairbanks Geophysical Institute (UAF/GI). The Director of DGGS established Volcanology as a separate section in early 2007. Funds for DGGS participation in AVO come from cooperative agreements with the USGS through the USGS Volcano Hazards Program.

AVO studies volcanoes to increase understanding of hazards at particular volcanoes and how volcanoes work in general; monitors volcanoes using seismology, geodesy, satellite remote sensing, field studies, and local observers; and provides timely and accurate warning of increasing unrest and eruptions to emergency management agencies, other government entities, the private sector, and the public. The majority of Alaska’s 52 historically active volcanoes are remote from human settlements, but all underlie the heavily traveled north Pacific passenger and cargo air routes between North America and Asia; thus the aviation sector is an important recipient of AVO monitoring reports.

The vulnerability of local infrastructure to active volcanoes was illustrated by the near flooding of the Drift River Oil Terminal by lahars (volcanic mudflows) generated on three separate occasions during the spring 2009 eruption of Redoubt Volcano. In addition, important transportation hubs at Cold Bay, Unalaska/Dutch Harbor, and Adak are all downwind from nearby active volcanoes, and construction began in the spring of 2010 on a ~4,500-foot airstrip 15 miles downwind from Akutan Volcano.

In FY2014, DGGS played a significant role in monitoring and responding to eruptions of Pavlof and Veniaminof volcanoes.

The three component agencies of AVO each bring particular strengths to the observatory, while sharing general expertise in volcanology. Among these agencies, DGGS is a leader in outreach, geologic studies, and petrologic and geochemical studies. DGGS builds and maintains the AVO website www.avo.alaska.edu, serving a large database of descriptive material about volcanoes, providing a cutting-edge system for intra-observatory communication and data sharing, and providing notices of eruptions and unrest to users in public, private, and government sectors. The database and information dissemination tools built around the database have emerged as the most powerful such tool among volcano observatories worldwide, and portions of the software designed and written at DGGS are in use at other volcano observatories, both nationally and internationally. Additionally, DGGS leads geologic studies at some volcanoes (currently Chiginagak and Kasatochi) and participates in geologic studies at others (currently primarily Okmok and Makushin).

DGGS coordinates acquisition of whole-rock geochemical data on samples from all AVO geologic studies and maintains the growing database of results. DGGS participates in eruption response, and coordinates and procures helicopter services for all AVO field projects. In FY2014, DGGS published the final year’s water geochemistry data from the Chiginagak volcano acid-flood project, completing an 8-year environmental monitoring of acid water input to Mother Goose Lake.

**ALASKA GEOLOGIC MATERIALS CENTER**

The Alaska Geologic Materials Center (GMC) in Eagle River holds nonproprietary rock core and cuttings representing nearly 13.7 million ft of exploration and production drilling on Federal, State, and private lands of Alaska, including the Alaska outer continental shelf. Additionally, the collection holds more than 260,000 linear ft of diamond-drilled hard-rock mineral core, representing over 1,800 exploratory boreholes; rock samples from more than 1,700 oil and gas exploratory or production wells; samples from geotechnical test wells; and numerous surface rock samples. The GMC maintains extensive geochemical data and reports derived from third-party sampling, and has an archive of more than 188,000 processed slides, including petrographic thin sections and paleontological glass slides.

During FY2014 the GMC hosted 362 visits to the GMC in Eagle River by industry, government, and academic personnel to examine rock samples and processed materials. Visits in FY2013 totaled 315. Collaboration from the FY2014 visits helped acquire 1,026 processed slides, oil and gas samples representing 628,541 feet from 88 wells, hard-rock mineral core representing 9,000 feet from one mining prospect; and publish six new laboratory data reports derived from third-party analyses. An online version of the Alaska GMC inventory http://dggs.alaska.gov/gmcinventory was released to the public in April 2010. This dataset, available in Google Earth Format, includes oil and gas well locations, mineral prospect locations, sample types, and box-level details for over 85% of the materials inventory available at the GMC. The online inventory allows users to quickly search for materials of interest.
and easily view details of the GMC's materials repository before visiting the facility. The GMC served 3,599 downloads of the online inventory in FY2014.

The GMC's complete inventory is at 192% capacity of the original heated warehouse space, with overcapacity housed in unheated metal shipping containers. Recognizing the need for additional room for the growing collection, DGGS management, the Department of Natural Resources Commissioner's Office, the Department of Administration, ECI/Hyer, and the Governor's Office secured a new building for the GMC in July 2013. The new facility will help safeguard the future accessibility and security of the valuable geologic samples currently archived by the State. Preparations are underway to move the collection, with an opening date for the new facility slated for FY2015.

ARIZONA
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Since 1988, the Arizona Geological Survey (AZGS) has been an independent state agency, reporting directly to the governor. We trace our roots to the Office of the Territorial Geologist established in 1888. From 1893 to 1988, the agency then became part of the University of Arizona, and operated under a number of institutional names. The mission of AZGS remains steadfast; inform and advise the public about the geologic character of Arizona in order to increase understanding and encourage prudent development of the State's land, water, mineral, and energy resources.

In recent years, and in the face of annual budget shortfalls at the state level, AZGS has increasingly turned to external funding sources to fund projects of state, national, and international scope.

STATE OF THE SURVEY
In Fiscal Year 2014, the Arizona Geological maintained its core functions in addressing natural hazards and natural resources in Arizona, and not only cemented our role as a national leader in geoinformatics and geoscience cyberinfrastructure but expanded our impact globally as well.

AZGS's State appropriation in FY2014 was similar to FY2013. Much of the Survey's funding continues to come from grants and contracts. We added several new positions due to growth in contracts and grants and we now have 42 full-time and two part-time employees in our Tucson and Phoenix offices, up from 16 in 2008. In FY2014, we also engaged several paid interns and nearly a dozen volunteers.

In June 2014, our Phoenix branch moved from temporary space near the capitol complex to be co-located with the Department of Water Resources at 3550 N. Central Ave, Phoenix, AZ, with much better public access and enhanced ability to collaborate between our agencies.

GEOLOGIC MAPPING
Dr. Jon Spencer and Dr. Phil Pearthree continue to oversee AZGS's STATEMAP program. The AZGS received a STATEMAP award of $151,162 for FY2014, which was matched with $151,261 in State funds. In FY2014, the AZGS STATEMAP mapping program targeted three map areas: (1) New geologic mapping along the Colorado River between Lake Havasu City and Parker improved understanding of copper and gold deposits in the western Buckskin Mountains and sand and gravel deposits derived from the ancestral Colorado River; (2) New mapping southwest of Quartzsite on the east side of the Colorado River examined the distribution of sand and gravel resources derived from the ancestral Colorado River and identified details of the stratigraphy of the Bouse Formation; and (3) New geologic mapping of Kingman, and Sacramento Valley to the west of Kingman, identified potential geologic hazards associated with flooding and with volcanic materials that underlie much of Kingman.

AZGS published six 7 ½' Quadrangle geologic maps produced with STATEMAP funds. In March 2014, work on the Rocky Mountain Carbon Capture and Sequestration contract with DOE was completed and a final report filed (Rauzi, S. L. and Spencer J.E., 2014).

The Arizona Oil & Gas Conservation Commission, administered and supported by the AZGS, issued 44 drilling permits and 21 wells were drilled in FY2014; nineteen for potash exploration in the Holbrook Basin; 2 wells were drilled near St. Johns, Arizona, to characterize carbon dioxide resources.

GEOINFORMATICS
DR. STEPHEN RICHARD, CHIEF
The Arizona Geological Survey's Geoinformatics team comprises 4 full-time employees and a handful of rotating interns. One of the team's chief objectives is to deliver digital data—e.g., AZGS geologic maps, tables, and reports—in such a way that the user audience can easily get the data, and can control how they view or use the data. This interoperable data system approach, which packages data into standardized interchange exchanges for use in many systems, has resulted in several major contracts of national and now international scope.
The survey continues its leadership role in cyberinfrastructure for the geosciences, particularly data sharing, through the AASG/USGS cooperative project, the U.S. Geoscience Information Network (USGIN) and successful implementation of USGIN through the National Geothermal Data System (NGDS). Additionally, AZGS is actively engaged in the National Science Foundation’s EarthCube initiative, taking the lead on developing a working model of the governance. We continue to participate in the International Union of Geological Sciences—Commission for the Management and Application of Geoscience Information (IUGS-CGI) Working Group efforts to develop and implement digital information exchange standards (e.g. GeoSciML) as well as the USGS National Geological and Geophysical Data Preservation Program and USGS National Cooperative Geologic Map Database project.

One of the highlights of the year was the formal launch of the National Geothermal Data System by U.S. Secretary of Energy Ernest Moniz at the White House Energy Datapalooza, in Washington, DC in May 2014. NGDS went operational as a federated data network with over 10 million data records covering 30 different types of data, from 60+ contributing data providers in all 50 states. AZGS has managed this Department of Energy project since 2010 on behalf of the Association of American State Geologists. NGDS is the largest application of the US Geoscience Information Network (USGIN).

Geoinformatics staff presented at a variety of conferences and events, including: American Meteorological Society Annual Meeting, USGS National Map Workshop, Geological Society of America Annual Meeting, American Geophysical Union Fall Meeting, Geothermal Resources Council Annual Meeting, and the European Geophysical Union General Assembly, among others.

**ECONOMIC GEOLOGY**

**MINING & MINERAL RESOURCES**

NYAL NIEMUTH, CHIEF

AZGS’s Economic Geology division monitored mineral exploration and production in Arizona. Arizona’s non-fuel mineral production ranks 2nd in the nation, with a value of approximately $7.54 billion for 2013. Approximately 65 percent of the nation’s annual copper production is in Arizona. Arizona is also one of the top five producers of aggregate and sand and gravel. Active exploration programs are underway across the state for copper, gold, silver, manganese, iron, uranium, rare earths, and potash.

Nyal Niemuth, Economic Geology Section Chief, reports significant progress scanning and creating metadata for 1,000s of records inherited from the former Arizona Department of Mines and Mineral Resources mine file collection. Much of these data are now freely available at the new Arizona Geological Survey Mining data site, [http://minedata.azgs.az.gov/](http://minedata.azgs.az.gov/). In addition to serving industry with mining and exploration data, one of this Section’s critical services is providing information and cooperating with regulatory agencies regarding the sale of mining securities.

**ENVIRONMENTAL GEOLOGY**

DR. PHIL PEARTHREE, CHIEF

Geologic hazards in Arizona include landslides, debris flows, rock falls, earthquakes, floods, earth fissures, expanding or shrinking soils, radon gas emission, and, less commonly, volcanic activity. Section geologists played a vital role in our STATEMAP efforts, contributing mostly Quaternary mapping to seven 7½” quadrangles in Arizona. New earth fissures were mapped by AZGS Staff, and the AZGS is releasing new versions of Earth Fissure Study Area Maps that include orthophoto base maps and InSAR maps showing active land subsidence. Among geologic products published this year, we included a Goggle Earth ‘Earth Fissure Viewer.’

The Arizona Broadband Seismic Network, maintained and monitored by AZGS, recorded dozens of small magnitude earthquakes during the last fiscal year. The largest earthquake recorded in FY2014 was an M 5.3 event located near Duncan, on the border between Arizona and New Mexico. Dozens of felt aftershocks occurred in the weeks following the main event. In July 2014, AZGS geophysicist Jeri Young deployed a temporary network of six portable seismometers to monitor activity there. In western Arizona, the AZGS carried out geohydrologic studies in cooperation with the State Land Department to help assess groundwater resources on trust lands.

**GEOLOGIC EXTENSION SERVICE (GES)**

DR. MICHAEL CONWAY, CHIEF

The GES maintains a geoscience library of more than 13,000 volumes, hosts the AZGS publishing and distribution house, operates the Arizona Experience Store, maintains and provides content for multiple websites, and supports the graphical and multimedia requirements of other AZGS divisions. Our two primary websites are [http://www.azgs.az.gov](http://www.azgs.az.gov) and [http://repository.azgs.az.gov](http://repository.azgs.az.gov); the former is the electronic face of the AZGS; the latter hosts over 1,000 digital bulletins, reports and geologic maps published by AZGS and its predecessor agencies. A third website, the award-winning Arizona Experience, [http://azionalexperience.org](http://azionalexperience.org) celebrates and explores facets of the geography, culture, and history of Arizona.

GES supports public and education outreach programs, including AZ Shakes and the Great Arizona ShakeOut—earthquake preparedness programs. In October 2013, more than
116,000 Arizonan's participated in ShakeOut's Drop, Cover and Hold On exercise. The GES team filmed and released 12 episodes of the Arizona Mining Review—an e-Video Magazine [https://www.youtube.com/user/azgsweb](https://www.youtube.com/user/azgsweb).

Each year GES staff field hundreds of public inquiries and makes scores of presentations and exhibits. We continued to expand our investment in social media—including highly active and successful Facebook, Twitter and Youtube accounts—as a vehicle to reach our stakeholders.

The Arizona Experience Store markets and sells AZGS geologic products, topographic maps of Arizona, and numerous hiking and specialty maps, complemented by a broad array of popular geologic and natural history books and multimedia products. The GES team comprises a geologist, web designer, text editor, tech transfer specialist, bookstore manager and graphic designer. We act as the marketing and promotional branch of AZGS and support the graphics, video, text and web needs of the other divisions.

### SPECIAL OPERATIONS

**KIM PATTEN, ASSISTANT DIRECTOR**

AZGS has assembled a world-class team of facilitators, coordinators, and evaluators to identify and resolve the cultural, social, and organizational challenges to building cyberinfrastructure in the sciences.

The NSF-funded EarthCube [www.earthcube.org](http://www.earthcube.org) effort to develop cyberinfrastructure for the geosciences is undertaking an unprecedented effort in community engagement and consensus building to get past the primarily cultural, social, and organizational barriers that have prevented a true cyberinfrastructure from emerging out of the billions of dollars spent on technical advances over the past 15 years. AZGS manages the EarthCube Test Enterprise Governance project which is setting up a community-driven demonstration governance structure, following a series of facilitated stakeholder assembly workshops, community-engagement activities and crowd-sourcing of organization models and processes. One of the results was a participant-initiated agreement to form a Council of Data Facilities (CDF) among federal-run and federally-funded data facilities and centers.

The Belmont Forum coalition of science funding agencies in 13 countries took on the issues of e-infrastructure and data management last year to support their core mission of global change research. On behalf of NSF, AZGS co-chairs the Belmont Forum e-Infrastructure and Data Management Steering Committee and Secretariat [www.bfe-inf.org](http://www.bfe-inf.org), along with Dr. Robert Gurney of the University of Reading (on behalf of NERC in the UK) and provides the staff support to the project’s six international Work Groups. The World Data System from ICSU is an active participant as is the European Commission. Each participating country is providing a delegation of 10–15 domain scientists, computer scientists, and social scientists (i.e., lawyers, IP experts, historians, etc.) to serve on 6 work packages. AZGS chairs the U.S. delegation. Our mission is to complete a global assessment of capabilities, needs, and gaps over the next year, and make recommendations as to what the Belmont Forum countries can most effectively or uniquely do (invest in) to further our cyber capacity for global change research.

### SELECT PUBLICATIONS FY 2014

In FY2014, AZGS published a number of reports and maps. Below are representative examples showing the breadth and diversity of AZGS offerings. Note: All FY2014 publications are available at the AZGS Document Repository [http://repository.azgs.az.gov](http://repository.azgs.az.gov) as free PDF downloads.


The California Geological Survey (CGS) is the primary source of geological and seismological products and services for decision making by California’s government agencies, its businesses, and the public. The Survey is a division within the Department of Conservation, which is under the umbrella of the Natural Resources Agency. The CGS has its headquarters in Sacramento and six field offices throughout the state. The CGS employs 110 geologists, engineers, seismologists, GIS cartographers, field instrument technicians, and clerical staff. The CGS has four separate funding sources. At any given time, the CGS manages projects under about 50 individual contracts. Today, the CGS operates seven separate programs authorized by five legislative acts.

The Survey’s mission is to provide scientific products and services related to the state’s geology, seismology, and mineral resources, including their related hazards that affect the health, safety, and business interests of the people of California.

GEOLOGIC MAPPING

Geologic Mapping is a core program within CGS. Each year CGS completes new geologic mapping, compiles geologic maps into regional maps and works to publish geologic of California. Geologic maps are prepared with support from the USGS National Cooperative Geologic Mapping Program, with state funding, and through contracts with state agencies. These maps provide the geological basis for many of the other CGS programs. The CGS plan for geologic mapping has been developed in consultation with the California Geologic Mapping Advisory Committee (CGMAC). This plan has established priorities for geologic mapping based on the following factors:

- Geologic threats to life and safety, including seismic shaking, liquefaction, slope stability, surface faulting, flooding, naturally occurring asbestos, and sources of radon gas.
- Population density and projected development, including transportation corridors and utility infrastructure.
- Potential threats to water quality or habitats from erosion, landslides, and flooding.
- Regional identification of natural resources, particularly in areas targeted for urban development.
- The adequacy and availability of existing geologic mapping to addressing these needs.
- Areas of scientific need to help address broader, regional geologic framework questions.

Regional geologic maps prepared by CGS provide a foundation upon which CGS builds a variety of derivative maps, including maps of geologic hazard regulatory zones. Because geologic map unit boundaries may become boundaries of regulatory zones, new large-scale mapping must show the distribution of both bedrock and surficial deposits with consistent methods and standards. Local mapping experience is also important for the diverse geology, climate, and morphology of California. For these reasons geologic maps that may become the basis for regulatory zones are prepared by geologists from regional CGS offices having local experience in mapping landslides and other surficial deposits, as well as bedrock.

MINERAL RESOURCES

The oldest of the CGS’s programs, Mineral Resources provides unbiased, technical information about non-fuel mineral resources in California to Federal, State and local government agencies, industry, and the public. This information enables them to make informed land-use and long-term planning decisions that will impact the economic and environmental future of their communities, regions, and the State. Mineral resource lands are classified by the state geologist as to their economic value, based upon criteria adopted by the State Mining and Geology Board. The program also produces an annual report summarizing the State’s non-fuel mineral production. Additionally, Mineral Resources provides technical assistance on issues related to mineral hazards such as, radon, heavy metals, and naturally occurring asbestos in the environment. Current projects include the production of radon potential maps for the Department of Health Services and mineral hazard maps for the Department of Transportation.

Publications since the last version:

- April 29, 2014—California’s Non-Fuel Mineral Production for 2012
- January 31, 2014—Radon Potential of the Palos Verdes Area, California
• December 10, 2013—Update of Mineral Land Classification: Aggregate Materials in the North San Francisco Bay Production-Consumption Region, Sonoma, Napa, Marin, and Southwestern Solano Counties, California

FOREST AND WATERSHED GEOLOGY
This program performs mapping and analysis of the geology of the state’s forests and watershed basins. Specifically, the program deals with landslide potential and stream load sedimentation. Under contracts with the Department of Forestry and Fire Protection, this program annually reviews between 400 and 600 Timber Harvest Plans for their potential geological impact to the harvest areas. The Forest and Watershed Geology unit maintains four regional offices in northern California in addition to the Sacramento headquarters. The program also is involved with the state Parks and Recreation Department, providing mapping of various features of the state’s parklands.

SEISMIC HAZARDS ZONATION
Under this program are three major projects. The first is authorized by the Alquist-Priolo Earthquake Fault Zoning Act, in which active faults (as defined by the State Mining and Geology Board as having movement in the Holocene—approximately the last 11,000 years in California) are zoned where they express surface rupture. Construction of structures for human habitation within these regulatory zones generally is prohibited. The CGS has zoned more than 5,000 miles of active surface faults in the state, publishing 584 quadrangles displaying those zoned faults. Approximately 2,000 additional miles of active surface faults remain to be zoned.

Seismic Hazards Mapping is a major project, authorized by the Seismic Hazards Mapping Act. This project zones the extent and likelihood of secondary hazards after an earthquake, such as ground liquefaction and triggered landslides, in urbanized areas. Under this project, 115 maps have been produced covering more than 7,000 square miles. These maps are regulatory in nature and enforced by local permitting agencies.

Work continued on the joint CGS—California Emergency Management Agency Tsunami Hazard Mitigation and Preparedness Program. Preliminary probabilistic inundation maps for portions of the California coastline were evaluated and shared with representatives of two pilot study communities, Crescent City and Huntington Beach. Partnerships exist with the University of Alaska and Humboldt State University to assist in tsunami inundation modeling and development of a tsunami deposit database. Meetings are frequently held with local emergency managers throughout California’s coastal communities in support of tsunami preparedness and eventual certification as “Tsunami Ready” as part of California’s partnership in the National Tsunami Hazard Mitigation Program (NTHMP). A CGS tsunami field-response team has been formed, with support from NTHMP, to enable collection of valuable information before and during tsunami events that can help assess damage, facilitate response operations, and be used to validate tsunami inundation models. Future products under construction include tsunami hazard maps for land-use planning and construction in all coastal communities and tsunami map products for the maritime community to help improve the resiliency of infrastructure and to provide guidance for evacuation to designated safety areas during tsunami events.

SEISMIC HAZARDS ASSESSMENTS
The construction of new schools, or structural modifications to existing schools, requires a permit from the Division of the State Architect. Before the issuance of a school construction permit, the CGS reviews consulting reports describing the school site’s geology and seismic hazards to ensure that those hazards, if any, are taken into consideration in the construction
of the school. Failure to thoroughly and adequately evaluate existing seismic hazards will prevent the school from receiving a construction permit. The CGS reviews reports from approximately 400 school sites each year and makes field checks of sites where fault-trenches are exposed. Also under this program, the CGS evaluates the seismic hazards site conditions for hospital construction for the Office of Statewide Health Planning and Development Safety Board (OSHPD). Hospitals must be constructed in strict accordance with OSHPD standards. The CGS reviews consulting reports from approximately 70 hospital sites each year. Earthquake risk and loss assessments also are conducted for “critical structures” under this program, wherein local and regional damages to the infrastructure are calculated and analyzed for various earthquake scenarios along major fault systems.

**STRONG MOTION INSTRUMENTATION PROGRAM (SMIP)**

This earthquake engineering program commenced in 1971 and has evolved into the largest Strong Motion Network in the nation, with more than 1,250 stations and more than 8,900 instruments installed in hundreds of structures and ground-response sites throughout the state. Strong motion information gathered by this network is provided to the earthquake engineering and structural design communities to improve the earthquake resiliency of California’s structures. Ultimately, this information is incorporated into the building code. The CGS SMIP network comprises the largest part of the California Integrated Seismic Network (CISN), which is a partnership with the California Emergency Management Agency (CalEMA) and the networks of the USGS, Caltech, and UC Berkeley. The CISN is an integral part of the USGS Advanced National Seismic System (ANSS).

Development and expansion continues, in partnership with the USGS, of the Center for Engineering Strong Motion Data (CESMD). Strong motion data from throughout the U.S. and from around the world are sent to the Center for processing, display, and archiving. Data arriving from the CISN system are automatically processed and offered on the Internet within minutes of an earthquake. Earthquake data from different parts of the world may take several days to post because of some countries’ data-holding policies. The Center’s archives may be accessed at [http://strongmotioncenter.org/](http://strongmotioncenter.org/).

This year, some of the SMIP projects included placing a new type of autonomous instrument along major faults in southern California. These instruments are much more economical than conventional instruments, allowing many to be deployed at close-in distances where there is little recorded data. SMIP also completed installing hundreds of instruments (accelerometers) on the recently opened East Bay extension of the San Francisco Bay Bridge and in numerous hospitals and other structures. The Bay Bridge is the most extensively instrumented structure in the U.S. The first data was recovered from instruments recently installed in the One Rincon Hill Building at the end of the Bay Bridge in San Francisco and the Bay Area Rapid Transit (BART) system that lies on the bottom of the San Francisco Bay. The 64-story Rincon building is the most densely instrumented residential high rise building in the U.S. Live monitoring of the building is being conducted by the USGS.

**LIBRARY/PUBLICATIONS AND OUTREACH**

By statute, since 1880 the CGS maintains a geological research library for its staff and conducts public outreach and education activities that include a publications unit and website. The library contains about 100,000 documents, including rare maps and publications on a host of geological topics. The library is open during regular business hours to all government and education researchers and to the public four days a week.
The Colorado Geological Survey now has a permanent home on the campus of the Colorado School of Mines. Founded in 1874, the Colorado School of Mines is a public research university devoted to engineering and applied science. Though CGS is no longer part of state government, our public service mandate remains the same.

The survey employs 14.5 geologists and other professionals. The programs and priorities of CGS are largely set in statute and did not change as a result of the transfer. Below is a sampling of the work completed in 2013-2014:

**Land Use Review Program**

<table>
<thead>
<tr>
<th>Proposed Developments Reviewed</th>
<th>Totals by Hazard Identified</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Landslides</td>
</tr>
<tr>
<td>Acres of Land</td>
<td>1,400</td>
</tr>
<tr>
<td>Number of Building Sites</td>
<td>596</td>
</tr>
</tbody>
</table>

For over four decades, CGS has assisted local governments with geologic hazard problems and other geologic concerns related to proposed land-use changes. CGS reviews proposed developments for geologic hazards and constraints and makes recommendations on hazard avoidance and/or mitigation to local officials. A summary of 2013-14 activity is outlined below.

**STATEMAP Program**

The CGS STATEMAP program received $164,294 for FY 2013-2014 from the US Geological Survey as part of the National Cooperative Geologic Mapping Program (NCGMP). This is the 16th year that CGS has participated in the NCGMP. The program supports mapping of geologic hazards, and water, mineral and energy resources in critical areas.

With the current grant, CGS mapped four quadrangles, which includes areas with extensive outcrops of coal-bearing strata and deposits of construction materials along major transportation corridors. CGS mapping also included areas of projected high population growth and numerous geologic hazards were identified.

**GROUNDWATER**

Colorado’s total population grew 1.52% to 5,268,367 between July 1, 2012 and July 1, 2013, ranking as the 4th fastest in annual percentage growth and 5th fastest in absolute growth in the nation.

The CGS groundwater program primarily focuses on counties where development pressures, in combination with prolonged drought, are straining limited groundwater resources and where comprehensive county-wide assessments have not been done. CGS recently completed its assessment of Park County.

Park County, located southwest of Denver, has experienced a substantial increase in development. Long-term sustainability of groundwater resources is a concern for local government officials. CGS completed a comprehensive assessment all aquifer types within the county; including near-surface unconsolidated aquifers and bedrock aquifers as well as crystalline rocks in mountainous areas. Data will be made available to the public in a web-based viewable format.

**GEOTHERMAL**

Colorado has numerous direct-use geothermal applications that range from an alligator farm, mountain resorts with hot springs, a town district heating system, greenhouses to geothermal heat pumps in public and private buildings. However, there are high temperatures below most of Colorado’s mountains and valleys, and power generation is possible if sufficiently high-temperature resources are available at reasonable depths.

Recent studies by the Colorado Geological Survey have found promising conditions at nine areas in Colorado, most notably in the Chalk Creek area near the Mount Princeton Hot Springs Resort. CGS is continuing to refine statewide and regional geothermal map(s) using bottom-hole temperatures (BHTs), heat flow, basement radiogenic heat production data, and oil and gas well fluid data.

Private resorts and community hot springs in Colorado are a great attraction and play an important role in the state’s recreation and tourism industry. Some local communities are concerned that power development, from deeper geothermal resources, may impact existing geothermal resorts that draw millions of visitors each year. CGS is working with state, industry groups, and local communities to develop consistent land-use regulations that help ensure future power development is done in a manner that protects public interests and the environment while encouraging expanded use of Colorado’s geothermal resources.

**GEOLoGIC HazARDS**

During September 2013, nearly continuous rainfall caused widespread landslides and flooding in the northern Colorado Front Range. Landslides and flooding were responsible for eight fatalities and caused extensive damage to buildings, highways, and other critical infrastructure.

CGS responded and quickly developed potential hazard maps, and made this information available to the public and emergency managers. Our geologists assessed risks to critical
facilities, infrastructure, and buildings, and developed recommendations to mitigate hazards.

In 2014, a large landslide occurred on the north flank of Grand Mesa, in the western part of the state. The slide claimed the lives of three local residents. The slide deposit is about 40 million cubic yards, 2.5 miles long and covers an area of about 600 acres. The slide generated a 2.7 M earthquake. A large sag pond has formed below the main landslide scarp and poses safety risks to downstream property. CGS helped first responders with rescue and recovery efforts and we continue to evaluate risks.

MINERAL AND MINERAL FUELS

Colorado has a great variety of mineral resources; more than 770 minerals have been catalogued in the state. CGS completed mapping of potential construction aggregate, industrial minerals, placer gold, rare-earth elements and sandstone hosted uranium, vanadium and copper on 23 quadrangles across the state.

Colorado has eight coal regions and produced over 23 million tons of coal in 2013. It is the nation's eleventh largest coal-producing state, and a leader in clean coal resources. Colorado also has extensive shallow coal beds that produce gas. Since 1975, CGS has collected trace element and coal chemistry samples from across the state and each year stratigraphic data is collected from new coalbed methane wells. With this and other information, CGS conducts ongoing coal availability studies and updates reserve estimates.

CGS PUBLICATIONS

Analysis of Borehole Temperature Data from the Mt. Princeton Hot Springs Area, Chaffee County, Colorado, Morgan, P., 2013, Search and Discovery Article #80327.


The Connecticut Survey is responsible for coordination and implementation of statewide natural resource data collection inventories in the following areas: surficial and bedrock geology, mineral and mineral resources, inventories of fauna and flora, including endangered species; and the development and operation of resource oriented data base management systems. The mission of the Connecticut Geological and Natural History Survey is defined in the Connecticut State Statutes (Ch 462, Sec 24-1 to 24-4). In the Department of Energy and Environmental Protection, the Geological Survey is within the Commissioner's Office, Office of Information Management (OIM) and the Natural History Survey is within the Bureau of Natural Resources (BNR) Wildlife Division.

**PROGRAM TRENDS**

The Survey’s principal effort continues to involve statewide geologic and biologic inventory mapping, database enhancements, and development of derivative products for use in environmental policy and management decisions. The Survey continues to conduct resource mapping in State Parks and Forests, and make significant contributions in DEEP program areas related to water resources, aquifer protection, land use and conservation, and endangered species. During the last 20 years, the Natural History Survey has operated the CT Natural Diversity Data Base that manages information on State listed species and significant natural communities. Survey staff participated in the development of the CT Aquatic Nuisance Species Management Plan. The Survey has also developed basic resource data sets for Long Island Sound in cooperation with the University of Connecticut. Survey publications continue to update the selection at our DEEP Store with more than 1,000 titles available, covering the natural resources of Connecticut.

The Geological Survey is focusing on greater involvement of students and academic partners in Survey work, and hosting academic partners on sabbatical leave appointments. Under a new 5 year cooperative agreement, the State Geological Survey opened an office at the University of Connecticut. The goal of this office is to engage students in educational collaborations in applied geoscience and environmental projects. These educational collaborations not only provide valuable work experiences for students, but also contribute to the State’s environmental protection efforts furthering the work of DEEP and the Survey in the areas of improved geoscience information for natural resources conservation, environmental quality, and outdoor recreation.

**GEOGRAPHIC INFORMATION SYSTEM (GIS)**

The central GIS operation for the Department of Energy and Environmental Protection resides in OIM. OIM manages the DEEP/GIS database, which is accessible to all DEEP staff. DEEP utilizes the system of ESRI GIS products including ArcGIS, ArcSDE, ArcView, and ArcGIS Online (AGOL). The primary long-term goal of the GIS program is the development of an integrated spatial information system that incorporates and regularly updates all of the basic data layers necessary to support the Department’s research, planning and management activities. Surficial materials, Quaternary geology, bedrock geology, and soils are available for use in GIS. DEEP’s GIS data is downloadable through the agency’s web site [www.ct.gov/deep/gisdata](http://www.ct.gov/deep/gisdata).

An existing Web-based GIS tool, CT Environmental Conditions Online (CTECO) is available through a partnership between the DEEP and the Univ. of Connecticut. This application provides users direct access to geography-based, natural resource and environmental information such as aquifer protection areas, watersheds, flood zones, geology, soils, water supply wells, open space, and imagery. With CTECO, basic environmental conditions can be assessed anywhere in Connecticut by mapping online, without GIS experience or software. A map catalog is available to view or print pdf formatted maps of these environmental themes by Town, 7.5 minute Quadrangle, or Statewide. A variety of orthophotography (1990–2010) is also available. CTECO also provides direct connection to desktop GIS or CAD software to ArcGIS and WMS map services as an alternative to downloading GIS data files. [http://www.cteco.uconn.edu](http://www.cteco.uconn.edu)

Several new online web based mapping/information sites have been developed using ESRI Arc GIS Online (AGOL) portal software. These include survey and parcel level information for DEEP property, and an interactive Connecticut Garnet Trail.

**AERIAL PHOTOGRAPHY**

All historic low altitude statewide flights (1:12) are available through the CT State Library or the University of Connecticut. This includes some 4 band color, infrared. Detailed oblique photography is also available for agency use. Connecticut LiDAR 10-foot DEM data is available statewide for download through the University of Connecticut [http://clear.uconn.edu/data/data.htm](http://clear.uconn.edu/data/data.htm) Other LiDAR derivative products are also available.

**TOPOGRAPHIC MAPPING**

OIM maintains statewide published topographic maps at scales of 1:24,000, 1:50,000 and 1:125,000. In cooperation with the USGS, Digital Line Graph (DLG) 7.5-minute quadrangle information and Digital Raster Graphics (DRGs) were produced for the state before the year 2000. A joint funding agreement between DEP and USGS has provided high resolution National Hydrography Data (NHD) for Connecticut.
**Geology**

The Connecticut Survey is continuing to develop cooperative partnerships toward the goal of improved geoscience information for DEEP programs and the citizens of Connecticut. Bedrock and surficial geologic mapping, topical research projects, and educational initiatives are pursued through a combination of Federal, State, academic, and non-profit collaborations.

**Quadrangle Mapping**—An educational mapping project of Indiana University funded through the National Cooperative Geologic Mapping Program (EDMAP) was conducted in the crystalline rocks of the Orange Milford terrane in the western part of the New Haven Quadrangle, in south central Connecticut.

**Applied Geoscience Analyses-Hazards/Geophysics**—The Connecticut Geological Survey is a contributor to the Connecticut Natural Hazard Mitigation Plan. The most recent update of the plan (2014) included proposed projects involving improve identification of escarpments susceptible to landslide and fluvial erosion risk; mapping historic underground mining operations to evaluate risk of land subsidence; geophysical research to evaluate soil stability during seismic events; adoption of an EarthScope seismic station as part of the New England Seismic Network.

**Resource Inventory and GPS Mapping**—Field mapping services are provided to units within the Department of Energy and Environmental Protection's Conservation Branch. These units include Land Acquisition, Boating, Parks, Forestry, Fisheries, Greenways, and Natural Areas. Mapping activities include: Trail mapping in Parks and Forests, Facility mapping of State Parks, Public Boat Launches, Biologic and Geologic features of significance, and Establishment of Survey Benchmarks. Hard copy and digital map products are available through the DEEP store and online.

**The CT Geologic Sites Database**—An ongoing program of documenting institutional knowledge. Database verification and enhancements are the focus of ongoing Geological Survey field work. Recent components relative to mining activities and mineral collecting locations have contributed data to The CT Office of Legislative Research, the USGS Eastern Region Minerals Yearbook, and routine technical assistance to DEEP programs, consultants, and citizens. The geologic sites database is also a central resource for Geological Survey land acquisition reviews within the DEEP.

**Geothermal Resources**—Connecticut Geological Survey and The Office of The Massachusetts State Geologist completed collaboration on a 3 state multiyear geothermal resources project supported by the US DOE and AAGS. The project focused on geochemistry of granites and granitic gneisses, to derive thermal conductivity estimates and generate thermal profiles for use in mapping areas of geothermal potential. All geochemical analyses, mapping tools, and related data is part of the National Geothermal Data System [http://www.geothermaldata.org](http://www.geothermaldata.org) with the support of AAGS [http://www.stategeothermaldata.org](http://www.stategeothermaldata.org).

**Soils**—Geochemical Survey of Connecticut Soils and Water Quality Investigations were conducted through a Joint Funding Agreement between the CT Survey/DEEP and the USGS, Connecticut Water Science Center. Soil chemistry from 100 sites in Connecticut collected by CT Survey staff and analyzed through the USGS Geochemical Landscapes Project was compared with the USGS Lithochemical Map, and NRCS soil mapping. The investigation contributed to the understanding of natural background levels for 42 analytical constituents, many of which are environmentally important trace elements, including Iron, Arsenic, Cadmium, Cobalt, Chromium, Copper, Lithium, Manganese, Nickel, Lead, Tin, Uranium, Vanadium, and Zinc. Other elements of note include Silver, Sulfur, and Tungsten. The research summary is available through the online journal Northwestern Geoscience.

**Collections/Data Preservation**—As a participant in the National Geological and Geophysical Data Preservation Program, the Geological Survey is formalizing collections as GIS data layers and making the information available to academic researchers and the public. Geoscience data preservation efforts are ongoing for the library collection of books, manuscripts, maps, scientific specimens, and unpublished survey files. The Connecticut Rock Core Repository, Educational Hand Sample Collection, and dinosaur track catalog have also been described online. Survey Historic Biennial Reports and Unpublished Map Files are available through the State Survey web site (archive area) [http://www.ct.gov/deep/cwp/view.asp?a=2701&q=487928&deepNav_GID=1641](http://www.ct.gov/deep/cwp/view.asp?a=2701&q=487928&deepNav_GID=1641) and from the USGS National Digital Catalog [http://ndc.sciencebase.gov](http://ndc.sciencebase.gov) Physical access to the Connecticut Survey library is by appointment.

**Marine Geology**—A geologic cooperative between the CT Survey and the USGS, Coastal Program of Woods Hole, Mass. supported marine geologic investigations (sediment distribution, modern processes, benthic habitats, etc.) and the interpretation of sidescan surveys from NOAA in Long Island Sound, from 1980–2010. A full catalog of this work can be found at [http://www.lirsch.ucconn.edu/lirsch/about.asp](http://www.lirsch.ucconn.edu/lirsch/about.asp). Currently, sea floor mapping is being coordinated by the DEEP Office of Long Island Sound Programs. A group of State and Federal agencies, along with academic cooperators from NY and CT are involved in the effort.

**Outreach and Education**—The CT Survey is an active participant in Earth Science Week, CT DEEP’s Teach Out, and Earth Day education initiatives. Survey publications, support of teacher training on the geology of Connecticut, online geologic descriptions of CT State Parks, and Earthcache sites [http://www.earthcache.org](http://www.earthcache.org) all contribute to the agency outdoor education effort of “No Child Left Inside”. A new online Connecticut Garnet Trail highlights locations of Connecticut’s State Mineral on public land, and provides additional outdoor recreational opportunities [http://bit.ly/1L3bcmW](http://bit.ly/1L3bcmW)

**Student Engagement**—The State Geological Survey opened a new office at the University of Connecticut, in Storrs. The goal of the new office is to engage students in collaborative research initiatives in applied geologic and environmental research in Connecticut. University students are able to work with the State Geological Survey through student internships, part-time employment, approved independent studies, and volunteer opportunities on a variety of projects involving bedrock, glacial materials, soil, ground water, and publications. These education-
al collaborations not only provide valuable work experiences for students, but also contribute to the State’s environmental protection efforts furthering the work of DEEP in the areas of natural resources conservation, environmental quality, and outdoor recreation.

The University of Connecticut, Department of Natural Resources and the Environment, chaired by John Volin, is hosting the State Survey Office, under a new five-year cooperative agreement between the University and the DEEP. Students from the Natural Resources and the Environment Department, Civil and Environmental Engineering, and Integrative Geosciences are welcome to apply for work at the State Survey Office.

**Connecticut Interstate Fire Crew**—The Connecticut Survey’s GIS specialist is a 25 year veteran and active member of the CT Interstate Fire Crew coordinated by DEEP’s Forestry Division. This crew provides all incident response, as part of a multi-jurisdictional incident management team including professionals from the NFS, BIA, BLM, FWS, State Governments and others. Recent wildfire suppression mobilization for Lolo National Forest, MT in Summer 2013. [www.NIFC.gov](http://www.NIFC.gov)

**Biology**

In addition to conducting basic inventories of the state’s biota, the Natural History Survey maintains the Natural Diversity Data Base (NDDB), which is an inventory of historic and current information about State and Federally listed plants, animals and significant natural communities. The Natural History Survey is a member of NatureServe’s National Heritage Network and uses Biotics, a nationally accepted GIS and database application designed by NatureServe, to manage this information. The Natural History Survey coordinates regular updates to Connecticut’s list of Endangered, Threatened and Special Concern species list. Biologists provide technical assistance through the environmental review process, and are involved in identifying and protecting significant ecological areas.

**Publications**

[www.ct.gov/deep/geology](http://www.ct.gov/deep/geology)


On-line publication sales [http://www.ctdeepstore.com](http://www.ctdeepstore.com)

(860) 424-3555 or 424-3692 or e-mail [deep.store@ct.gov](mailto:deep.store@ct.gov)
The Delaware Geological Survey (DGS) is a science-based, public-service-driven Delaware state agency organized, by statute, under the charge of the University of Delaware. The DGS is responsible for systematic investigation of the geology, water resources, and natural hazards of the state, preparation of reports and maps, and advising state officials on the optimum utilization and equitable administration of the state's geological resources.

The DGS is a unique agency within Delaware state government because we are both a state agency and a University research and service unit. Financial, personnel, and other administrative matters are managed by the University. The DGS budget is funded by an annual direct appropriation from the State of Delaware with related reporting responsibilities to both the Office of the Governor and the Delaware General Assembly. The DGS provides objective, factual information that affects public policy decisions, and aids in solutions for individuals, business, and industry. In addition, we contribute to the educational mission of the University through collaboration with faculty and students, and by providing students and interns hands-on experience working with DGS researchers, and exposure to our scientific equipment. The DGS became formally affiliated within the University's growing College of Earth, Ocean, and Environment (CEOE) in July, 2008. Most DGS scientists have secondary faculty appointments in the College's Department of Geological Sciences.

Our research and service activities are focused on five areas: (1) geology; (2) hydrology; (3) natural hazards; (4) the state geospatial framework; and (5) information dissemination. DGS activities in these areas impact a wide variety of issues, including water resources, agriculture, environmental protection, energy and mineral resources, economic development, land-use planning, emergency management, public health, coastal issues sea-level rise, and recreation. Our responsibilities have continued to grow over the years and our program priorities continue to evolve to ensure that we are aligned with the highest priority needs of Delaware’s citizens. For example, the high rate of population growth and associated development throughout Delaware necessitates evolution of our work plans to anticipate areas of strategic future importance, including increased emphasis on determining the occurrence, availability, quantity, and quality of groundwater resources from our aquifer systems, increased emphasis on land-based wastewater disposal, and efficient and effective dissemination of information and spatial data via electronic means such as the Internet.

David R. Wunsch is the state geologist and director of the DGS. Previously, Wunsch served as the state geologist and director of the New Hampshire Geological Survey from 2000 to 2010, and also served as the Director of Science & Technology at the National Ground Water Association in 2010/11. Karen D’amato is the executive assistant to the Director, and chief financial officer. Laura Wisk is our administrative assistant.

GEOLOGIC INVESTIGATIONS AND SERVICES

The DGS geology program includes surficial geologic mapping, subsurface geology, and coastal geology. Our efforts focus on issues that impact the quality of life of the citizens of Delaware. Many areas of the state have shown significant growth and development over the last several years. DGS geological investigations provide supporting information for management of natural resources in light of these increasing public needs and environmental pressures, with a wide variety of applications including groundwater, land-use, natural hazards, environmental geology, soils/agriculture, geotechnical engineering, coastal protection, and beach nourishment.

Surficial geological mapping is a major element of the DGS geology program. In 2014, DGS published four geologic maps series: No. 19 (Frankford and Selbyville), No. 20 (Millsboro and Whaleyville), No. 21 (Trap Pond, and portions of Pittsville), and No. 22 (Sharptown, Laurel, Hebron and Delmar) Quadrangles. The current mapping program, which began in July 2014, is the Middletown Quadrangle and a portion of the Cecilton Quadrangle. These maps will significantly advance understanding of the near-surface geology of the state through integration of geomorphology derived from high-resolution topographical data (LiDAR).

DGS manages and has submitted statewide map services of 1:100K scale surficial geologic units and 1:100K scale surficial geologic contacts. These services support both WMS and WFS protocols with data attributes supporting the GeoSciML-portrayal schema. Currently, DGS maintains a Four Star web service accreditation rating. DGS is one of only five states in the US that participate in OneGeology and is working with the developers on documentation and testing for an open source implementation.

The DGS maintains the Atlantic Outer Continental Shelf Core and Sample Repository. This repository includes nearly all remaining sample materials related to geologic investigations conducted offshore the eastern coast of the United States, and has been recently utilized by parties anticipating possible future interest in potential offshore East Coast energy (e.g., wind) resources. Issues related to the impact of recent and future sea-level rise on Delaware’s coast also are of growing interest. In 2014, DGS was awarded $200,000 from the federal Bureau of Ocean and Energy Management (BOEM) for funding to explore additional sand resources in federal waters off shore of Delaware. This is a one-time BOEM project that is supported by Hurricane Sandy Supplemental Funds.

DGS was also awarded a grant from the USGS NNGDPP to continue with ongoing efforts in preserving historical well and outcrop descriptive information. This project focuses on the conversion of paper well and outcrop records into a digital format so that they can be preserved, stored in a database, and made available through the internet. As of September 2014, all DGS Sample books, outcrop descriptions, and well descriptions have been scanned to PDF files; which includes 6,216 outcrop
descriptions, and 32,000 well schedules converted to PDF files.

The DGS continues numerous activities and responsibilities involving interaction with other government agencies on geology-related issues. These include: service as a permanent professional member of the Delaware Board of Geologists; acting as the state’s interface and primary cooperator with the U.S. Geological Survey and the U.S. Bureau of Ocean Energy Management, Regulation, and Enforcement; service as Delaware’s representative on U.S. Department of the Interior’s Outer Continental Shelf Policy Committee; cooperation with the Minerals Information Team of the USGS in compiling sand and gravel production data for the state; service on the Association of State Boards of Geology (including a term as President); serving on the Delaware Geographic Data Committee Executive Council; and generally advising state and local government organizations on coastal geology issues ranging from shoreline migration to sand characterization. State geologist David Wunsch is statutorily assigned as the Delaware principal to the Delaware River Master Decree Party, and also represents the Association of American State Geologists on the federal Advisory Committee on Water Information (ACWI) and the ACWI Subcommittee on Ground Water. Wunsch also serves as President of the AASG Foundation, a 501(c) 3 organization that supports the public service and education activities of AASG.

HYDROLOGIC INVESTIGATIONS AND SERVICES

Surface water and groundwater are among Delaware’s most important natural resources. DGS hydrology program activities include studies of the occurrence, availability, quantity, and quality of groundwater resources, aquifer and water-table mapping, unconfined and confined aquifer hydrology, groundwater modeling, groundwater discharge to surface-water bodies, and water-resource issues associated with land-based wastewater disposal.

The DGS has completed a water supply study for Kent and Sussex Counties at the request of the Delaware Water Supply Coordination Council, of which the DGS is a member. The project is designed to provide and assess of water resources that will include evaluation of groundwater availability, historic and current water use, current water allocations, refined characterization of water withdrawal by major aquifer, and projections of future water requirements through 2030. DGS staff has also been active in the development of thermal imaging applications as they relate to hydrology. One project uses thermal-imaging to map the spatial and temporal distribution of tidal inundation on a salt-marsh platform. The other project uses ground-based multi-spectral thermal imagery to map spatiotemporal topographic variability and help characterize hydrologic and sedimentary processes and properties in tidal wetlands and sand/mud flats.

As an ongoing responsibility, the DGS is the lead agency for collection and analysis of data on groundwater levels and stream discharges in Delaware. In 2011, DGS was awarded funds to enhance the state’s groundwater monitoring network in southern New Castle and Kent counties. Well installation is nearly complete, currently groundwater levels are monitored in 34 monitoring wells with automated data loggers. More than 800,000 observations have been collected to date. Data are reviewed by DGS for quality control and then are available from DGS on-line sources. Water samples were collected from new and existing monitoring wells at eight sites. Trace metal results show that roughly 30 percent of samples from the Mt. Laurel and Rancocas aquifers contain total dissolved arsenic concentrations in excess of the Delaware maximum contaminant level (MCL). Conventional radiocarbon results indicate that water in deeper confined aquifers entered the ground as recharge between 6,000 and 16,000 years before present.

We will also continue to track surface-water conditions using 16 stream-gage and 9 tide-gage stations that are maintained around the state in cooperation with the USGS. The DGS advises water-resource management decisions through ongoing monitoring of water conditions, summarized monthly in a Summary of Water Conditions available on the DGS website, and through participation on committees such as the Governor’s DroughtAdvisory Committee, Delaware Water Supply Coordinating Council, and the Northern New Castle County Groundwater Availability Technical Advisory Committee (TAC). We also continue our role in interfacing with federal, interstate, state, county, municipal, and local agencies on a variety of other water-related issues via: Delaware River Master Advisory Committee, the Decree Party Workgroup and Regulated Flow Advisory committees of the Delaware River Basin Commission, New Castle County Resource Protection Area TAC, Inland Bays Scientific TAC, and the Delaware TMDL Technical Advisory Committee. The DGS co-chairs the Data Management and Data Standards Workgroup, which is part of the ACWI Subcommittee on Groundwater. The DGS has statutory responsibility for dealing with its federal counterpart agencies, such as the USGS, in matters related to hydrology.

GEOLOGIC HAZARD INVESTIGATIONS AND SERVICES

The DGS has ongoing responsibilities for understanding natural hazards in Delaware and advising appropriate emergency management agencies on these hazards and related mitigation and response. Flooding hazards, including stream flooding and coastal flooding, and seismic hazards are the main focus of our efforts.

The DGS maintains a network of five seismological stations in Delaware to monitor earthquake activity. The seismic signals are captured digitally using Earthworm, a seismic processing system developed by the USGS, and are shared with the Lamont-Doherty Cooperative Seismicographic Network and the Center for Earthquake Research and Information. We also are part of the Northeast U.S. Seismic Network and the Southeast U.S. Seismic Network. DGS adopted two (2) multi-channel, broadband seismometers that were installed in 2013 as part of the national Earthscope Transportable Array (TA) program. We have upgraded our recording hardware, and added two 52-inch, high definition monitors that display real-time seismic data from our TA sensors, as well as other educational information provided by a feed from IRIS to enhance our seismic hazard and risk monitoring, public education, and outreach.

The DGS is a regular participant in assessing flooding risks due to storm events throughout the year. Staff participate in statewide interagency emergency management coordination conference calls convened for major storm events and provide real-time evaluation of stream-flow and tide-gage data and meteorological information. We cooperate with the Office of the State Climatologist and the Delaware Emergency Management Agency (DEMA) in the maintenance of the Delaware Environmental Observing System (DEOS), a real-time system for monitoring environmental conditions. In our effort to assist emergency managers, the DGS, in cooperation with the Delaware Environmental Observing System, placed new data loggers and
cell phone modems at 7 coastal tide gages in Delaware. Minutes count during a tidal flooding event, and this system will provide an advantage to emergency managers and scientists by having access to 6-minute updated gage height information prior to and during coastal storms. These high-quality data loggers and cell modems will provide significantly higher resolution tidal information to evaluate and mitigate emergency situations resulting from coastal storms. The data are currently available over a web interface for near real-time access.

**GEOSPATIAL INVESTIGATIONS AND SERVICES**

DGS activities related to geospatial investigations and services continue rapid growth. This past year DGS had to discontinue the Delaware DataMIL datamil.delaware.gov, which was an internet map service that served current versions of the Delaware Digital Spatial Data Infrastructure layers to the public. However, the data layers are still available through DGS and some of our state and university partners. In August of 2012, DGS recently released a beta-version of a new web-based tool for the delivery of geologic and geospatial information. The Delaware Geologic Information Resource, or DGIR, is a new web service that combines a multitude of databases and map services to produce a geoscience information tool specifically for professional users. Most of DGS digital products are migrating to DGIR.

The DGS led a multi-agency state and federal effort to secure $1.1M in funding from the Hurricane Sandy Relief program to collect new, high-quality LiDAR for the entire state of Delaware. This new elevation dataset will help to enhance watershed modeling for stream flooding, produce up-to-date topographic maps, predict and assess the impacts of storm surge and sea level rise, improve our geologic and land use mapping, measure changes in marshes and wetlands, and much more. DGS will store and maintain the new dataset as well as provide expertise for the State. Lidar data and other final project deliverables are expected in December, 2014.

DGS has entered into a partnership with the Arizona Geological Survey (AZGS) to participate in USGIN by establishing a metadata clearinghouse node for Delaware geoscience information and standardizing the format of the information to match Geoscience Markup Language (GeoSciML). Metadata on the Delaware node, which can be searched through the DGS website or other online USGIN nodes, have descriptions and contact information, associated downloadable datasets, and direct links to open map services (WMS, WFS, WCS) for each dataset. All surface geologic maps published since the release of Geologic Map 8: Geology of the Milford and Mispillion River Quadrangles, Delaware, in 1993, are available through USGIN. DGS submitted a completed contract report in July 2013, and continues to be actively involved in USGIN activities.

**INFORMATION DISSEMINATION**

The DGS ensures the results of our work are of use to our stakeholders through our programs of publication and outreach. Publication has traditionally been the main focus of our information dissemination program and the last year has seen a continued growth into the digital realm. The Delaware Geological Survey unveiled a new version of its public website www.dgs.udel.edu in 2010. Although many of the technologies employed are consistent with modern web standards, giving the user a familiar feel and comfort level, this version pays particular attention to the retrieval of information. The DGS also conducts education and public outreach on issues related to earth science through presentations, workshops, and building tours. We regularly participate in the University's annual Coast Day, an annual open house and festival at the College of Earth, Ocean, and Environment bayside campus in Lewes, Delaware. Outreach related to geospatial issues have included Geographical Information Systems (GIS)-related teacher-development activities and service as key organizing committee members for next year's state GIS conference. DGS also held its first Delaware Geology Symposium in 2013, which was very successful and attracted approximately 110 attendees. Our Second Symposium will be held in April of 2015, and every two years thereafter.

DGS also continues to collect information annually from state surveys in order to update and disseminate the AASG Directory as a service to the Association.
The Florida Geological Survey (FGS) can trace its origin to the Office of State Engineer and Geologist established in 1853; however, it was not until 1907 that an autonomous Florida Geological Survey was established by the Florida Legislature. The FGS is headquartered in the Gunter Building which was named for the second State Geologist of Florida and is located in Tallahassee, the State Capitol, on the campus of Florida State University (FSU), adjacent to the Department of Earth, Ocean and Atmospheric Sciences. The FGS also maintains office space, laboratories, a core-and-well-cutting sample repository, and publications storage at an annex in Tallahassee. The Geologic Data Acquisition and Management Program employees are housed at the annex. The FGS is an office within the Florida Department of Environmental Protection (FDEP). The Director of the FGS serves as the State Geologist and oversees the administration, geological and hydrogeological research and other activities of the Survey.

The FGS is organized into five sections: Administration, Geological Investigations, Applied Geoscience Services, Geoscience Information and Data Management, and Geological Sample Acquisition and Management. The Survey’s Administration Section consists of Operations, IT Coordination and Special Projects. This section is responsible for administration (budget, department and interagency liaison, etc.), contract and grant tracking, personnel management (travel, leave, benefits, etc.), IT administration and infrastructure support, and Gunter Building maintenance and repair.

The Geological Investigations Section collects and interprets statewide surface and subsurface geophysical and geological data. It conducts geologic, geomorphic and mineral resources mapping and maintains, updates and disseminates information on Florida’s lithostratigraphic nomenclature. The Geological Investigations Section is responsible for maintaining the sub-sidence incident reports database and responds to requests for sinkhole and other geologic hazard assessments. It sustains the core statutory mandate to investigate and report on Florida’s stratigraphy, mineralogy, sedimentology, and paleontology. The section provides expertise to state and federal agencies and the public, and provides outreach and educational opportunities for citizens highlighting the importance of geoscience.

The Applied Geoscience Services Section conducts aquifer vulnerability, aquifer storage and recovery, and arsenic/trace metal assessments. It delineates springshed boundaries and assesses related water quality issues. The section is also responsible for conducting surface and groundwater interaction studies, and creating potentiometric surface maps. The Applied Geoscience Services Section also conducts hydrogeological assessments and modeling for regulatory and land use applications.

The Geoscience Information and Data Management Section facilitates access to, organizes, and determines accuracy of FGS geologic information including project, acquisition, and location data. The section organizes GIS Data which includes managing databases of well records, outcrop descriptions, STATEMAP products, potentiometric surface maps, sinkholes, and digitally-converted paper documents with geologic information. The Geoscience Information and Data Management Section maintains and facilitates access to FGS publications and other scientific publications through the FGS Geological Research Library.

The Geological Sample Acquisition and Management Section maintains the FGS Geological Sample Repository and provides access for research by the academic, scientific, regulatory, and private sector communities. It obtains rock and sediment cores and cuttings and maintains these acquisitions within the FGS Geological Sample Repository. The section installs monitoring wells in support of projects involving groundwater quality monitoring, potentiometric surface mapping, and development of Minimum Flows and Levels (MFLs). The section maintains the FGS drill rigs and associated equipment to acquire geological samples and geophysical log data. It also maintains the R/V GeoQuest, other FGS research vessels, and associated data-acquisition equipment to conduct offshore geophysical data and geological sample acquisition.

Overall, the FGS staff includes 30.5 full-time positions, 19 research assistants, and nine interns. The geologic staff is supported by micropaleontology, sedimentology, hydrogeology, and scanning electron microscopy labs; a geologic research library; a sample repository with over 19,400 sets of well cuttings, cores, and outcrop samples; ground-penetrating radar equipment; a Mobile Drill B-31 core and auger rig, a Schramm T450MIA is capable of a total coring depth of 3,000 feet, a CME 75 drilling rig with associated support vehicles, seven four-wheel drive field vehicles and four research vessels (boats) with data-acquisition equipment.

**FEDERAL GRANT RECEIVED TO CONDUCT STATEWIDE ASSESSMENT OF SINKHOLE VULNERABILITY**

In the fall of 2014, the Federal Emergency Management Agency (FEMA) awarded $1.08 million to the FGS, in conjunction with the State Division of Emergency Management (DEM). The purpose of the award is to conduct a statewide assessment of sinkhole vulnerability in Florida. The three-year project started with a one-year pilot study in Hamilton, Columbia and Sumter counties. The study will culminate in the production of a model that will generate a map showing the relative vulnerability of these counties to potential sinkhole formation. The resulting model will then be used to produce a statewide map during the following two years.

The request was sparked by Tropical Storm Debby, which brought heavy rainfall to Florida in June 2012, triggering the formation of sinkholes. In the months leading up to Tropical Storm Debby’s record rainfall event, most of Florida had been experiencing extreme drought conditions, resulting in lowered water levels in aquifers. The result was an outbreak of sinkholes when rainwater caused dry underground voids—previously filled with water—to collapse.

Environmental regulators, growth management planners, the construction industry, and local governments can use this
information about sinkhole vulnerability in Florida to develop protective designs and strategies. Such protective designs and strategies will potentially reduce loss of life and property by lessening the impact of sinkholes on Florida's population and infrastructure. Other benefits of this project include a better understanding of sinkhole susceptibility, an increased understanding of Florida's karst terrain and hydrogeology, and how these affect the state.

**FGS AND FWC CONDUCT SOUTHWEST FLORIDA CONTINENTAL SHELF PROJECT**

The FGS joined the Florida Fish and Wildlife Conservation Commission (FWC) in a research effort on the Southwest Florida Continental Shelf. Because the preservation of sport and commercial fisheries is important to the state of Florida, the FWC requested vessel support from the FGS. A research vessel, the R/V GeoQuest, was supplied for the project, complete with its captain, Julian Stringer. The vessel deployment ran from late April through early August 2013.

The FWC, via the Florida Marine Research Institute (FMRI), supplied side scan sonar equipment, funding, and project collected data that allows shelf geomorphology to be more broadly tied to reef-fish habitats. These data are used by FWC to direct sampling efforts for the Florida Marine Research Institute's reef-fish independent monitoring program. The surveys were conducted along the west Florida shelf between latitudes 26 and 28 degrees N, in water depths ranging from 98 feet to 328 feet (30 to 100 meters). Over half of the locations lay in water depths from 98 to 197 feet (30 to 60 meters). Each cruise ran from five to six days in length with multiple sites being surveyed each day. Each site was surveyed with the collection of 6.3 nautical miles of side scan sonar data. Each site survey consisted of three 2.1 nautical-mile-long survey lines.

**DIRECTOR SPEAKS IN CHINA ABOUT SINKHOLES, AQUIFER PROTECTION**

Jon Arthur, FGS Director, gave two presentations at the International Research Center on Karst (IRCK) on November 25, 2013. These presentations were for the IRCK’s International Training Course on Karst Hydrogeological Investigation, Dynamic Monitoring and Application in River Basins. The course was sponsored by the United Nations Educational, Scientific and Cultural Organization in Guilin, China. The first presentation explained sinkhole types and occurrences in Florida and the other covered karst aquifer vulnerability. Additionally, Arthur lectured on Aquifer Vulnerability Modelling in Karst at the Department of Geographical Sciences in Southwest University in Chongqing. Geoscience professionals worldwide met at the training course, including Dr. George Veni, the National Cave and Karst Research Institute (USA) Director and Dr. Mikhail Bogdanov, the General Director of Russia’s Geologic Research Institute of Construction. The exchange of information during this trip provided the opportunity to learn more about the scientific challenges regarding karst worldwide. Arthur also met with Professor Jiang Yuchi, Director of the International Research Center for Karst, to discuss cooperative opportunities between the Center and the Florida Geological Survey.

This trip followed Dr. Arthur’s presentation to the National Research Council of National Academies Board of Earth Sciences and Resources’ Committee on Geological and Geotechnical Engineering on November 13, 2013 in Washington, D.C. Arthur presented information on the state's sinkhole vulnerability study as well as the general topic of sinkholes, including the impacts on the economy, the environment, and human health.

**INTERNSHIP PROGRAM GAINS MOMENTUM**

The FGS initiated an internship program during 2013 after determining demand for the program and a substantial number of student candidates seeking real job experience. Prior to this time, many potential opportunities for students were unfulfilled. Additionally, there was no mechanism in place to allow for the training and professional development of these eager and hardworking students. The program is designed to provide students with an opportunity to apply learned skills and develop new ones in a supervised professional environment. While the program is designed for giving students real world experiences in the environmental and geological sciences, FGS also exposes its interns to professionals in the geoscience field to promote career development.

The program has had unprecedented success and currently has nine undergraduate students enrolled. Several of the previous internship program graduates have gone on to take jobs within the FGS or have been placed at jobs in other state agencies. The interest level has been very high among the FSU Geography, Environmental Science, and Geology Departments. Participants in the program obtain valuable in-depth experience and knowledge about Florida’s geology, hydrogeology, ecosystem sustainability, and environmental protection. They gain expertise in approaches and techniques related to geographic information systems and science, database design and maintenance, geologic and water-quality sample collection, geologic mapping, geologic sample preparation and field work.

**FGS PROVIDES GEOLOGICAL SUPPORT FOR SRWMD AQUIFER RECHARGE PROJECT**

The Suwannee River Water Management District’s (SRWMD) Middle Suwannee River and Springs Restoration and Aquifer Recharge Project is an effort to rehydrate wetlands and recharge the Upper Floridan aquifer in southern Lafayette and northern Dixie counties. This project may increase local spring discharge and provide water for agricultural uses.

In November and December 2013, the water management district contracted the installation of piezometers and monitoring wells to obtain geologic and hydrologic information in the study area. This phase of the project required a geologist on-site. The SRWMD reached out to the Department for assistance with the oversight of the drilling, well installation, sample collection and preliminary aquifer testing. FGS Geologists Tom Greenhalgh and Dave Paul, along with Dennis Jensen of DEP Site Investigations, volunteered to assist the district with this phase of the project. The geologists kept field notes on the drilling process and lithology during the surficial split-spoon sampling, 8” surficial casing installation, 4” well casing installation, and final core drilling to complete the wells. They also ran specific capacity tests on the completed wells.

Additionally, FGS staff described the lithologic samples collected during the well installations. This included split-spoon samples as well as cuttings and core samples. The lithologic descriptions were completed and provided to the district in February 2014, and the samples added to the FGS statewide sample repository collection.
**FGS TO UPDATE**

**FLORIDA AQUIFER VULNERABILITY ASSESSMENT**

The Florida Geological Survey signed a Memorandum of Agreement with FDEP’s Division of Water Resource Management, Source and Drinking Water Program in April 2014 to produce an updated Florida Aquifer Vulnerability Assessment (FAVA). The incorporation of additional up-to-date data could improve the utility of the model. Improvements include increasing the number of model training points and resolution of data layers (evidential themes) along with revisions to extents of Florida’s major aquifer systems.

The goal of the project is to provide a more comprehensive model through additional input data and to extend the model domain. For example, the Floridan aquifer system extent will be expanded to include all of South Florida. Each of the evidential themes (e.g., overburden thickness, soil hydraulic conductivity, and proximity to probable karst features) will be updated. Additionally, the FGS will reassess training point criteria and modify the input as required by the model. Upon completion of the revised FAVA model, FDEP staff will work to include other Florida aquifers.

**FLORIDA GEOSCIENCE WORKGROUP INITIATED**

The FGS coordinated a Florida Geoscience Workgroup (FGW) comprised of representatives from Water Management Districts, FDEP division and district offices. The workgroup is a forum to discuss geoscience issues facing DEP and WMD program areas. It fosters communication about data and research, and provides educational opportunities for geoscientists in the form of webinars.

Two meetings a year of the FGW will be held via teleconference, and two educational webinars will include the workgroup as well as any interested agency parties. The first meeting was held on May 29, 2014 and included topics related to aquifer (hydrostratigraphic) nomenclature consistency, statewide sinkhole probability mapping, and other geoscience topics and case histories of interest.

All or part of the workgroup is called together as needed to consider issues of immediate concern by FDEP or WMDs and provide recommendations for consideration. The FGW also helps identify topical areas for the educational webinars.

**OTHER FGS FISCAL YEAR 2013–2014 PRODUCTS AND ACTIVITIES**

The following list is not all-inclusive; however, it includes additional FY 2013-2014 products and activities that may be of interest to other state geological surveys.

**PRESENTATIONS**

- July 2013, May 2014, and June 2014: Means, G.H. and Williams, C.P., Ten class lectures on various aspects of Florida geology, Florida’s Environment class, Department of Earth, Ocean and Atmospheric Science, FSU, Tallahassee, Florida
- October 2013: Williams, C.P., Florida geology and the local environment, Environmental Systems class, Tallahassee Community College (TCC), Tallahassee, Florida
- October 2013: Williams, C.P., Geologic and geomorphic mapping in northeastern Florida National Parks, Geologic and Geotechnical Engineering, Washington, D.C.
- November 2013: Arthur, J.A., Florida Karst geology, International Research Center on Karst, Guilin, China
- November 2013: Arthur, J.A., Karst aquifer vulnerability, International Research Center on Karst, Guilin, China
- November 2013: Arthur, J.A., Aquifer vulnerability modeling, Department of Geographical Sciences, Southwest University, Chongqing, China
- January 2014: Williams, C.P., Preliminary results of geologic and geomorphic mapping in northeastern Florida national parks, Timucuan Science and History Symposium, Jacksonville, FL.
- May 2014: Baker, A., Filling Critical Data Gaps from Private Wells or Water Systems, presentation to Florida Department of Health about FGS work on the Florida Aquifer Vulnerability Assessment project.
- May 2014: Arthur, J.A., South District Field Trip and Presentation on Florida geology

**PUBLICATIONS**


Green, R.C., Evans, W.L., III, Bassett, S.W., and Hannon, L.M., 2013, Geologic map of the U.S.G.S. Daytona Beach 30 x 60 minute quadrangle, northeast Florida, Scale 1:100,000, Florida Geological Survey Open File Map Series 105, 3 plates.


OUTREACH ACTIVITIES

• August 2013: Christopher Williams provided a tour of the FGS facility and discussed geoscience career opportunities with a TCC geology class.

• October 2013, Florida Geological Survey Earth Science Week Open House.


• October 2014, Jon Arthur visited Orlando Central District Office, Glenridge Middle School, and the Orlando County Public Library to present on sinkholes and Florida geology.

• October 2013: Jon Arthur traveled to Jacksonville to speak to Associated General Contractors. The goal was to educate Florida builders on sinkhole hazards and applications of sinkhole probability mapping towards improving safety.

• October 2013: Harley Means was a guest speaker for Professor Nadine Hadley-Brown’s Environmental Systems class (BSC 1050) at TCC. Florida geology and geology careers were discussed.

• October 2013: Jackie Lloyd assisted with Dr. Mabry Gaboardi’s TCC physical geology class field trip to St. George Island State Park. Study focused on coastal processes and the trip was developed with input from FSU’s Professor Dr. William Parker.

• October 2013: Dan Phelps presented the rock cycle to 40 first grade students at Kate Sullivan Elementary School.

• November 2013: Michelle Ladle and Lee Hartman displayed posters at GIS day, sponsored by Seven Hills Regional User Group for GIS. The poster titles were “Geologic Mapping in Two National Park Service Units in Northeast Florida” and “Risk and Liability Analysis Modeling for Hurricane Damage on Florida Bridges: A Geographical Information System Application.”

• December 2013: Harley Means led a field trip to Leon Sinks for a local home-school group.

• December 2013: Harley Means spoke to three 5th grade classes about Florida’s geology at Maclay School, Tallahassee, Florida.

• April 2014: Harley Means spoke to the Women’s Club of Chattahoochee about Florida geology.

• April 2014: Harley Means staffed a booth and provided lectures for the Marion County Springs Festival held at Silver Springs State Park, Ocala, Florida.

• April 2014: Harley Means led a film crew from NOVA to a limestone quarry in Marianna, Florida to aid in the production of a video about sinkholes.

• April 2014: Christopher Williams, Jim Cichon, and Lee Hartman convened a workshop at Timucuan Headquarters in Jacksonville, Florida for National Park Service and Florida Park Service staff to discuss the updated geomorphology and geology geodatabase for the area.

• June 2014: Jon Arthur was interviewed by the Weather Channel about sinkholes.

• June 2014: FGS geologists provided six presentations for the Leon County Branch Libraries. The topic was Leon County area geology, karst, and water resources.

FIELD TRIPS

• October 2013: Means, G. H., Stratigraphy of the Intercoastal Waterway from Panama City to Choctawhatchee, Florida, Southeastern Geological Society Field Trip

• November 2013: Paul, D., Alum Bluff, Apalachicola River, Florida Paleontological Society Field Trip

• December 2013: Means, G. H., Alum Bluff, Apalachicola River, Northwest Florida State College Geology Field Trip

• December 2013: Means, G. H., Northwest Florida State College Physical Geology Class Field Trip

• February 2014: Kromhout, C., University of South Florida Paleoecology Class Field Trip

• February 2014: Means, G. H., Alum Bluff and vicinity, 10th North American Paleontological Conference

• February 2014: Paul, D. T., Ground Penetrating Radar investigation to map a cavern at Florida Caverns State Park, Marianna, Florida

• March 2014: Means, H. M., Geology of Citrus County, Southeastern Geological Society Field Trip

• March 2014: Williams, C. P., Wakulla Springs and Leon Sinks, Ecology class, Maclay School, Tallahassee, Florida

• April 2014: Williams, C. P., Leon Sinks, Aberdeen University (United Kingdom), Tallahassee, Florida

• May 2014: Means, H. M., Woodville Karst Plain, Southwest Florida Water Management District
The Idaho Geological Survey (IGS) is the lead agency for collecting and disseminating geologic information and mineral data in the state. The agency has served the state since 1919 and prior to 1984 was named the Idaho Bureau of Mines and Geology. The IGS is a non-regulatory state agency that is administered as a Special Program of the University of Idaho. In addition to its main office in Moscow at the University of Idaho, the Survey has satellite offices in Pocatello at Idaho State University and in Boise at the University of Idaho Water Center and Boise State University. Survey staff includes eleven state-funded employees and 20–25 externally funded temporary and part-time employees. Staff geologists conduct applied research with a strong emphasis on producing geologic maps and providing technical and general information about Idaho’s geologic setting, earth resources, and geologic hazards. Externally funded projects enhance this research.

GEOREGONAL MAPPING AND DIGITAL MAPPING LAB

The Survey’s primary research activity is geologic mapping, resource identification, and assessment of geohazards throughout the state. The foundation of all IGS research projects is a dedicated effort of geologic mapping and publishing this information as 7.5’ and 30’ x 60’ quadrangles. Before 1990, geologic mapping in Idaho was primarily conducted in localized rural areas to facilitate extraction of economic geologic resources. In the last two decades, the Survey has been mapping in areas selectively to address development impacts in urban settings, for assessment of possible new geologic resources, and identification and monitoring of geohazards such as earthquake seismicity and landslides. The Idaho Geologic Mapping Advisory Committee assists the Survey by assessing Idaho’s mapping necessities and addressing long-term plans for geologic mapping. The committee guides the medium- and short-term mapping plans to take advantage of state partnerships. Idaho’s geologic map products have been used, for example, to designate landslide hazards; to define mineralization potential; to delineate rock units that form boundaries of aquifers; to show geologic materials for engineering needs; to better predict groundwater resources; to aid in highway design and construction; and to define geologic resources on public lands, including U.S. Forest Service and Bureau of Land Management lands, Idaho’s parks, recreation areas, and endowment lands.

Funding of Idaho’s geologic mapping program is shared by the STATEMAP component of the National Cooperative Geologic Mapping Program. Since 1993, Idaho has received over $3.5 million in federal funds and matched an equal amount of state money to complete geologic mapping in Idaho. During the year, Survey geologists mapped five 7.5’ quadrangles, and mapped and compiled one 30’ x 60’ quadrangle under the STATEMAP Program. Mapping was also conducted in the Stibnite 7.5’ quadrangle with funding provided by Midas Gold Corporation. Geologic mapping results were highlighted with numerous posters and talks at the joint Rocky Mountain-Cordilleran GSA section meeting in Bozeman in May. Also, IGS mappers led a 3-day field trip prior to the meeting across areas of Survey mapping from Pittsburg Landing in Hells Canyon to Lolo Pass on Highway 12.

The Survey’s digital mapping and GIS laboratory provides services that include digital cartography, spatial data management, database management and design, network system administration, graphic design, desk-top publishing, and website support. The lab continues to compile geology from around the state in geologic map databases, in addition to producing geologic map products. Eighteen 7.5’ geologic maps were digitized (as stand-alone or compilation efforts) and ten geologic maps were published this year. All are available as printed products or can be viewed free on the IGS website.

Databases continue to be an important way of managing and distributing information to IGS customers via our website. Database updates of active faults, mines and prospects, oil and gas wells, and Survey publications are an ongoing effort. The largest archive is the Mineral Property Files and associated Mine Map Collection both of which increased in size as donated files were indexed and scanned thanks to funding provided by the Idaho Department of Lands and the U.S. Geological Survey (USGS). Web delivery of the Mine Map Collection is anticipated for FY 2015. This year the Survey began to migrate geologic map data into the NCGMP09, a new national voluntary standard for geologic map data. This is being accomplished by both new conversion tools for migrating existing geologic data and redesigned capture tools in ESRI ArcMap for producing geologic maps and their datasets.

MINING AND MINERALS

Since its inception in 1919, the Idaho Geological Survey (IGS), formerly known as the Idaho Bureau of Mines and Geology, has been providing information for and documentation of the mineral industry of Idaho. The IGS collaborates with the U.S. Geological Survey in production of the Idaho chapter of the Minerals Yearbook, a widely used global compilation of developments and statistics in mining and minerals information. The 2013 calendar year Idaho mining review was presented at the Northwest Mining Association convention in December. While there were still many great projects, the signs of an industry slowdown were apparent. Due to declining commodity prices and the temporary closure of the Lucky Friday mine, Idaho’s nonfuel mineral production value for calendar year 2013 is estimated at $991 million, down significantly from the revised record 2011 value of $1.324 billion reported by the USGS. Molybdenum was the largest value commodity with phosphate rock being second in value for 2013. While markets for industrial minerals, including phosphate rock, were stabilizing, a lack of investor financing restricted exploration and development projects for junior companies in 2013, and only a handful reported new drilling. The larger projects included oil and gas exploration in southwestern Idaho, geothermal drilling at Raft River, gold exploration at the Stibnite and Beartrack deposits, and rare earth exploration in Lemhi County and adjacent Montana.
Work continued on two multi-year minerals research projects during FY14. The first project, a collaborative effort with the Idaho Department of Transportation (ITD), was completed in the first half of FY14 and published as a research report by ITD and as a Technical Report by IGS. The report and accompanying map document aggregate lithology from 40 Idaho concrete-certified sources and correlate it with measures of alkali-silica reactivity (ASR). Rock types of the aggregate samples were quantitatively inventoried and the data compared with the new geologic map of Idaho and other literature sources to identify potential aggregate source units. Petrographic study of mortar bars, prepared for commercial AASHTO T 303 testing of ASR expansion potential, was conducted to better understand which rock types are the most reactive. The research results were enthusiastically received by the ITD and presented at the Rocky Mountain Geological Society of America meeting in May.

The second project, funded by and in collaboration with Midas Gold Corporation, involved ongoing geologic mapping of the Stibnite 1:24,000 quadrangle and a petrologic and geochronologic study of the complex gold-antimony-tungsten mineralization in the Stibnite Mining District, Valley County. A second phase of the project received additional funding from Midas and will continue the research for two more years. Work during FY14 included continuation of geologic mapping, petrographic study, and geochronological sampling and analysis of detrital zircons, intrusives, and vein rocks. By the end of FY14, preliminary results from the geochronology were available and indicated evidence for a Paleozoic age of at least part of the mapped stratigraphic section. Collaborators at Boise State University measured several precise U-Pb ages for early Cretaceous plutons in the district, and the University of Alaska, Fairbanks, laboratory analyzed samples of potassium feldspar associated with mineralized veins. The argon ages on the vein-related feldspars were Eocene, consistent with textures seen in the petrographic work.

**OIL AND GAS**

The Idaho Geological Survey (IGS) maintains files on about two hundred historic oil and gas exploration wells in the state. These files include the reports and logs provided by companies to the Oil and Gas Commission from 1903–1988. The files were transferred to the IGS in 2009 from the Idaho Department of Lands and consist of drilling correspondence, permits and applications, reports, maps, and geophysical logs. Many are unique historic documents and in fragile condition. Recent geothermal and oil and gas exploration in Idaho has greatly increased the number of requests for these data. The Survey has now scanned all of the reports and logs and made them available for download from the IGS website.

Recent oil and gas exploration efforts in Idaho have been focused on the western Snake River Plain and areas to the north toward Midvale. One project of particular note is the development of the Hamilton and Willow gas fields in Payette County. Drilling from 2010 to recent has resulted in over 10 new exploration wells and production of Idaho’s first commercial gas from a well near New Plymouth. A new geologic mapping project, funded by STATEMAP and matching state appropriations, was initiated in June of 2013 in the Weiser 30’ x 60’ quadrangle. One goal of this work is to better understand the geologic setting of the current oil and gas play in this part of the state.

**GEOTHERMAL**

The Survey completed work on a three and a half year contract funded by the Department of Energy’s (DOE) National Geothermal Data System (NGDS) project. The $870,000 project was administered by the Arizona State Geological Survey (AZGS) and the American Association of State Geologists (AASG) to compile geothermal information and acquire new heat flow data (summarized below) to stimulate geothermal energy development in Idaho and the U.S. All data are cataloged in the NGDS and accessible via a browser interface.

- 2,733 geothermal and oil/gas exploration wells, including 996 well logs, 613 formation tops, 181 DSTs
- 1,255 whole-rock chemical analyses, including radioactive-elements, of igneous and volcanic rocks
- 404 thermal springs
- 249 Quaternary and younger faults (591 total Miocene to Holocene age faults)
- 191 previously unavailable bibliographic listings of Idaho-specific geothermal literature
- 102 new thermal conductivity measurements from three thermal gradient holes drilled in southeast Idaho
- 51 web and email links to Idaho-specific agencies responsible for permitting geothermal development
- 34 corrected heat flow measurements (31 deep wells + 3 shallow thermal gradient holes)
- 1 state digital geologic map and database

One of the major successes of the project which DOE/AASG are highlighting is the discovery of a previously unrecognized high-temperature geothermal resource in the Idaho thrust belt north of Soda Springs associated with magmatic heat beneath the Blackfoot volcanic field. A comprehensive set of reports documenting the geothermal potential of this area is currently being prepared, based on the results of the NGDS project. Presentations and published conference proceedings at the Stanford Geothermal Workshop (February), the Center for Advanced Energy Studies in June, and the Geothermal Resources Council (October), as well as presentations at Idaho universities during 2014 elicited considerable interest.

**HYDROGEOLOGY**

The Survey’s hydrogeological work comprises various areas of applied research, with elements of outreach and education. Research activities cover a wide range of topics, including aquifer hydrogeology; water levels and geochemical indicators of flow system processes; ground water contaminant sources; and water-supply potential of aquifers. Outreach and education activities involve ongoing communication with tribes, regulatory agencies, planners and private well owners around the state, as well as active participation in graduate teaching and research mentoring at Idaho State University.

Research activity in 2014 focused on geochemical tracing of flow systematics in the recharge source area of the lower Portneuf River Valley’s (LPRV) municipal aquifer, as part of the Idaho EPSCoR MILES project (Managing Idaho’s Landscapes for Ecosystem Services). The Survey’s funded research investigated the residence times, sources, and flow paths of ground water in the principal recharge corridor of the LPRV aquifer, an area that
has been a focus of much of IGS’s hydrogeologic research in the past. The project identified and quantified a deep ground water contribution to the LPRV system, constrained flow-system residence times with carbon-14 and tritium dating, and proposed a heretofore unrecognized source of recharge to the LPRV aquifer that originates as old, thermal ground water up-flow along the valley’s basin-bounding fault and a major unconformity at the base of the Tertiary section.

**GEOLOGIC HAZARDS**

Idaho is prone to earthquakes, volcanic eruptions, landslides, and flooding. The Survey works to support mitigation of these hazards in several ways:

Public awareness and status of on-going hazard events are addressed through website information and direct contact with the public and news media by e-mail, telephone, and occasional public lectures or field trips. Bill Phillips, IGS Research Geologist, has been identified by the University of Idaho as a designated point of contact for natural hazard issues. Requests to the University for Hazard Information are directed to the Survey in this way. For example, in April 2014, an earthquake swarm in the Challis area generated considerable media interest. Interviews of Survey staff concerning the swarm were presented on regional television, radio, and newspapers.

Survey staff is informed about Idaho earthquakes through seismic monitoring performed by the U.S. Geological Survey, Montana Bureau of Mines and Geology, the University of Utah, and the Idaho National Laboratory. When an earthquake occurs, location and magnitude data are automatically posted by the USGS to the internet. A Survey staff member receives automated emails and cell phone texts for Idaho-area earthquakes exceeding magnitude 3, and also checks the USGS site for regional activity on a daily basis.

The Survey is a member of the Western States Seismic Policy Council (WSSPC). The Council’s mission is to develop seismic policies and share information to promote programs that reduce earthquake-related losses. In FY 2014, a Survey staff member served as the chair of the Basin and Range Province Committee of WSSPC. This committee focuses on earthquake hazards of Idaho, Wyoming, Montana, Utah, Nevada, Arizona, and New Mexico.

The Survey collaborates with monitoring of the active Yellowstone volcanic system by the U.S. Geological Survey, the University of Utah, and Yellowstone National Park. The Survey is a member of the Yellowstone Volcano Observatory (YVO) Consortium together with the geological Surveys of Wyoming and Montana. A Survey staff member participates in bi-monthly YVO phone briefings and in FY2014 attended the YVO Consortium meeting at Mammoth Hot Springs, Wyoming.

The Survey provides expert opinion and advice to state and federal agencies involved with Idaho hazard mitigation. In FY 2014, the Survey performed the following hazard mitigation activities at the request of the Idaho Bureau of Homeland Security (IBHS):

- Participated in meetings of the Idaho Seismic Hazard Advisory Committee. This committee provides expert advice on issues related to earthquake hazards and risk reduction strategies.
- Participated in review and revision of the Idaho State Hazard Mitigation Plan. Updating the State Hazard Mitigation Plan qualifies Idaho for all available federal assistance in the event of disasters. It provides a framework to save lives and reduce vulnerability to natural and human made hazards. The Survey focuses on earthquake, volcanic eruption, landslide, and flooding portions of the plan.
- Partnered with the IBHS to produce an annual report for WSSPC on Idaho earthquake hazard mitigation activities. This report also documents earthquake activity occurring within Idaho.
- Conducted mapping of seismic site classes and liquefaction susceptibility in the Big Wood River area of Blaine County. This work was funded by IBHS and is available for free download on the Survey website.

Geological mapping conducted through the STATEMAP program provides baseline information on the location, magnitude, and frequency of hazards. This information is incorporated into planning documents and also serves as the basis for more detailed studies, such as mapping of landslides.

**EARTH SCIENCE EDUCATION**

The American Geosciences Institute sponsors Earth Science Education Week in cooperation with its member societies on behalf of the geoscience community. In October, the Survey distributed Earth Science Education Week packets to teachers at the Idaho Science Teachers Association meeting in Pocatello. In addition, over sixty State Geologic maps were distributed free to science teachers that were attending the conference from across the state. An additional 300 State Geologic maps were distributed by mail to all middle and high schools in the state, including teaching packets and points of discussion. Funding for the distribution of the maps was provided by the Department of Geological Science at the University of Idaho. This followed an earlier map distribution by the Idaho Gem Club to all of the grade schools in the state. Proceeds for that effort were obtained from sales of Earth Science and Lapidary specialty license plates.

The Idaho Geological Survey participates in meetings and field trips associated with the Pacific Northwest section of the National Association of Geoscience Teachers annual field conference. The Survey represents Idaho as a state councilor to the section. This year we presented status and discoveries of the IGS, and participated in field trips in and around Wenatchee, Washington.
Over the past year, the Illinois State Geological Survey (ISGS) has continued to move forward with research and service initiatives that have had a significant impact on the State’s energy and water resources, environmental protection, and economic development. The following are highlights from this year’s report: (A) In one of the nation’s most advanced demonstrations of geologic carbon storage, the Illinois Basin - Decatur Project, funded jointly by the U.S. Department of Energy, ADM, and the State of Illinois, has injected nearly 1,000,000 tonnes of supercritical CO₂ sourced from the largest ethanol plant in the world into a Cambrian-age sandstone 7,000 feet beneath central Illinois, and (B) the ISGS and its partners are actively working to investigate the effects of geologic carbon sequestration on potable water supplies. Since the 1980s, the ISGS has been working for the Illinois Department of Transportation (C) to evaluate environmental conditions for highway construction projects to assess properties that have the potential for various environmental hazards, natural features, and natural hazards, and (D) to evaluate the impact of highway construction projects on the preservation, construction, and maintenance of wetlands. This past year, a concerted effort has been made to evaluate and monitor the quality of runoff from tollways in the Chicago area. (E) Southern Illinois geologic mapping has identified an igneous intrusive diatreme that contains anomalous concentrations of the rare earth elements lanthanum and cerium. (F) The ISGS is collaborating with the Illinois Association of Aggregate Producers, GZA GeoEnvironmental, Inc., and McHenry County officials to inform the public, state and local governments, and planning agencies about sustainable aggregate production and the vital importance of the industry to economic development. (G) A 3-D geologic map of McHenry County, Illinois, has been completed and distributed publicly. The map serves as a framework for regional groundwater flow modeling, and it has already been utilized effectively by consultants to address possible locations for future municipal water-supply wells.

The ISGS, together with the Illinois Natural History Survey, Illinois State Water Survey, Illinois State Archeological Survey, and Illinois Sustainable Technology Center, form the Prairie Research Institute at the University of Illinois at Urbana-Champaign.

**CARBON CAPTURE AND STORAGE REACHES NEW MILESTONES**

Carbon capture and storage (CCS) from ethanol production represents a significant opportunity to mitigate climate change owing to its low cost of capture and the purity of the carbon dioxide (CO₂) produced. The Illinois Basin - Decatur Project (IBDP) is an integrated CCS project being conducted in Decatur, Illinois, by the Midwest Geological Sequestration Consortium (MGSC), led by the ISGS at the University of Illinois at Urbana-Champaign. The research objective of the IBDP is to conduct a full-cycle CCS project—from site characterization to closure—that will inject 1 million tonnes of anthropogenic CO₂ captured from biofuel production into a deep saline formation, the Mt. Simon Sandstone. The MGSC, one of seven U.S. Department of Energy Regional Carbon Sequestration Partnerships, was established to evaluate the safety and effectiveness of geological storage of CO₂. The IBDP has successfully completed nearly 3 years of CO₂ injection at a nominal rate of 1,000 tonnes/day, with cumulative injection of over 900,000 tonnes as of August 2014. The injectivity and capacity of the Mount Simon Sandstone have been confirmed. Cased-hole logging has shown that CO₂ volumes injected to date remain in the lower Mount Simon, and reservoir simulation shows the sealing capacity of the Mount Simon-Eau Claire Shale interface will not be tested even 100 years after injection of the 1 million tonnes has ceased. The integrated compression/dehydration, pipeline, and injection well system has operated as planned, with ADM carrying out injection operations 24/7 that are fully integrated with its ethanol production facility. Intensive environmental monitoring of the near-surface environment above the CO₂ plume has shown no effects on air, water, soil, or structural uplift during injection to date and none is expected. The availability of a high-purity CO₂ stream from ethanol production has allowed research and development of the project to focus on the integrity of the geologic reservoir-seal system.

Geological carbon sequestration (GCS) is a process of permanently storing greenhouse gases in the subsurface rather than discharging them into the atmosphere. This technology is considered a feasible approach to reducing greenhouse gas emissions and addressing global climate change. For GCS projects, monitoring, verification, and assessment (MVA) procedures are conducted to demonstrate that the sequestered CO₂ is securely and permanently stored in the subsurface. The MVA procedures include atmospheric, hydrological, geochemical, and geophysical monitoring techniques. This research project was designed to reduce uncertainties associated with selected MVA procedures. Specifically, the ISGS has sought ways to protect underground sources of drinking water from potential threats from GCS, which include leakage of CO₂ from the storage reservoir or upgradation movement of displaced brine.

This research project was supported by a U.S. Environmental Protection Agency Science to Achieve Results grant and included five separate but related tasks. Two tasks focused on geochemistry and three focused on hydrogeology and hydrology. Alternately, three tasks focused on compiling or generating basic data and two tasks focused on developing new methods. Basic data for the Illinois Basin were compiled and generated in three areas: geology/hydrogeology, geochemistry, and natural saline discharges. In the Illinois Basin, the Mt. Simon Sandstone is a deep saline reservoir with a vast GCS resource and is capped by the Eau Claire Formation. From natural gas storage fields and wastewater injection wells completed in these formations, more than 12,000 core porosity and permeability data points were compiled. Available aquifer test data were digitized and analyzed using new methods to estimate hydraulic parameters of the Mt. Simon and Eau Claire Formations. A new map of total dissolved solids within the Mt. Simon was developed. Laboratory experiments conducted at reservoir pressure...
The manual is a product of the PESA program developed by the ISGS, and it reflects work completed on more than 3,500 highway projects since March 1989 (see map). The rationale for this program is that state and federal laws require landowners to be aware of the environmental condition of the property they own or control. As the largest landowner in Illinois, IDOT routinely acquires property for new road construction and improvements to existing alignments, as well as for other infrastructure projects. Therefore, the agency must be able to assess environmental risks and liabilities associated with such properties to (1) protect worker and public safety, (2) reduce IDOT’s liability, given that environmental site assessments are conducted to determine the environmental condition of a site, and (3) minimize delays by operating in an efficient and cost-effective manner. Conducting preliminary environmental screening at an early stage in road improvement projects saves time and money, and allows IDOT to choose from a number of options regarding how to proceed. Identification of environmental conditions assists in defining the level of hazard that may be encountered during construction activities and provides guidance for further investigation of these conditions or for proceeding with the project.

This manual outlines standard operating procedures to ensure the consistent collection and presentation of environmental data. Employing individuals specifically educated and trained to collect and evaluate historical and physical evidence used for environmental risk evaluation is critical to the program. The procedures for data gathering and interpretation must be clearly stated and uniformly applied so that all assessments have the same relative value and can be correlated from project to project. Knowledge of problematic environmental conditions assists in defining the level of hazard that may be encountered during construction activities and provides guidance for further investigation of these conditions or for proceeding with the project.

Collectively, the results from these five tasks have led to a better understanding of the geochemistry and hydrogeology of the Mt. Simon and Eau Claire Formations in the Illinois Basin, which will help protect underground sources of drinking water from potential threats from GCS. Furthermore, the new techniques presented here are easily transferable to other GCS reservoirs around the world. The collective result of these efforts has been to reduce the uncertainty associated with protecting underground sources of drinking water from potential threats posed by GCS.

CONDUCTING PRELIMINARY ENVIRONMENTAL SITE ASSESSMENTS FOR ILLINOIS DEPARTMENT OF TRANSPORTATION INFRASTRUCTURE PROJECTS

The ISGS produced Circular 585, which is a manual for performing preliminary environmental site assessments (PESAs) for highway construction projects for the Illinois Department of Transportation (IDOT). The manual describes an ISGS site assessment program that provides information on environmental conditions associated with highway and other transportation projects. This program is in response to IDOT often acquiring properties that have the potential for various environmental hazards, natural features, and natural hazards that may be present on existing IDOT right-of-way or on sites that are proposed for acquisition.
MAJOR EXPANSION OF CHICAGO-AREA TOLLWAYS REQUIRES A MAJOR INCREASE IN WATER-QUALITY MONITORING BY THE ISGS

The Illinois Tollway partnered with the ISGS to monitor the quality of runoff from tollways in the Chicago area over the past several years, including evaluating the performance of bioswales installed in 2010 along I-294 as a best management practice (BMP) for treatment of runoff. Past results suggest that bioswales are largely successful at reducing the concentrations and loads of many pollutants in runoff. A major expansion of the tollway system is beginning, including reconstruction and expansion of I-90 and construction of additional segments of the Elgin-O’Hare Expressway and a new western access to O’Hare Airport. These projects are located in watersheds where water quality is already impaired, necessitating widespread use of BMPs to prevent further impacts.

The ISGS is beginning the next 5-year monitoring period and will continue to monitor the I-294 bioswales through 2019, but add preconstruction monitoring along several creeks in the area of upcoming construction, including discharge, specific conductivity, and turbidity, as well as other parameters. Additional monitoring will be installed as roadways are constructed and BMPs are implemented, including monitoring input to and output from selected bioswales and other types of runoff management features such as rock basins, porous sewers, and infiltration boxes. The goals of the monitoring include measuring reductions in pollutants across specific BMPs, measuring impacts to receiving waters by comparison of pre- and post-construction conditions, and identifying sinks for pollutants, including groundwater.

RARE EARTH ELEMENTS IN THE MIDWEST ASSOCIATED WITH THE ILLINOIS-KENTUCKY FLUORSPAR DISTRICT

Geologic mapping along the northern edge of the Illinois-Kentucky Fluorspar District (IKFD) located an igneous intrusive diatreme named the Sparks Hill Diatreme that contained anomalous concentrations of rare earth elements. A rock core drilled into this pipe-shaped feature was analyzed by energy-dispersive X-ray fluorescence spectrometry, which detected a maximum of 1,609 ppm lanthanum and 2,768 ppm cerium. In comparison, estimates of these two elements within shale in North America averaged 32 ppm lanthanum and 73 ppm cerium.

Through the use of an electron microprobe, rare earth fluorocarbonate was identified within the fine-grained igneous matrix between brecciated autolithic clasts and a rare earth phosphate in void spaces (see figure). The identification of rare earth minerals in the Sparks Hill Diatreme fuels speculation concerning potential mineable concentrations of rare earth minerals within the IKFD. Although the IKFD is generally described as a Mississippi Valley Type mineral deposit, implying that mineralization is not related to igneous activity, the rare earth minerals identified within the Sparks Hill Diatreme strongly support a carbonatite being present at depth beneath the IKFD. It is possible that fluorine was derived during the evolution of a deep-seated carbonatite, which then mixed with regional brines to form the IKFD ore deposits. Additional research is being conducted in southeastern Illinois to investigate the potential for economic accumulations of rare earth minerals and to determine the relationship between the igneous activity and the fluorite mineralization in this region.

PLANNING FOR SUSTAINABLE AGGREGATE PRODUCTION IN ILLINOIS

To increase awareness of aggregate sustainability, the Illinois Association of Aggregate Producers initiated a program in collaboration with the ISGS, GZA GeoEnvironmental, Inc., and the McHenry County Department of Planning and Development to present workshops on sustainable aggregate production to planners and other interest groups. Past workshops included presentations to the (1) joint Extractive Industry Geology Conference and the Forum on the Geology of Industrial Minerals (2014), (2) American Planning Association National Planning Conference (2013), (3) Illinois Association of County Engineers (2013), (4) Illinois Association of County Zoning Officials (2012), and (5) Upper Midwest Planning Conference (2011). The primary objectives of the workshops have been to (1) inform the public, state and local governments, and planning agencies about the vital importance of construction aggregates to infrastructure and economic development, and (2) emphasize that adequate supplies of construction aggregates require (a) analysis and understanding of the local geology and careful land-use planning (including 3-D geologic mapping), (b) collaboration between the mining industry and local communities and their residents, and (c) adoption of sensible and effective rules by communities for regulating aggregate production.

Illinois is challenged with the continuous loss of aggregate resources to urban development. The expansion of residential and industrial complexes and the lack of specific guidelines from government agencies for managing aggregate resources before they become sterilized continue to result in the loss of these important resources. Intense competition for land and mineral resources has increased the need for current, detailed geologic information ahead of pressing land-use decisions. Three-dimensional geologic mapping provides local, county, and state planning agencies with the necessary geological information in a simple, non-technical format to help them make informed decisions on land use, preservation, and protection of valuable aggregate resources while at the same time protecting the environment. Land-use planning, which recognizes the importance of preserving opportunities for the extraction of common minerals, is essential for obtaining the resources.
needed to build and maintain our communities and transportation systems. These are essential for balanced and sustainable growth and, in the long run, will save local, state, and federal governments from unnecessary expenditures. The cost of such mapping projects is minuscule considering the cost that local, county, and state agencies have to bear if the issue of sustainable aggregate resources is not addressed before or during urban/suburban development and growth.

The availability of aggregate resources is rarely incorporated into planning programs. Government agencies and industry must work together to ensure that affordable aggregate resources are available for current needs and future generations. McHenry County’s experience dealing with these issues in northeastern Illinois illustrates the importance of such cooperation. Gravel mining is a significant industry in this county. It is also a controversial industry, which many believe can easily have negative environmental, health, and infrastructural consequences. In the unincorporated areas of the county, the local government works to ensure that an economically important industry is allowed to continue while balancing the concerns of those with environmental (particularly water), health (noise and dust), and infrastructure (roads) objections. Through zoning ordinances and groundwater monitoring ordinances, the county is able to provide sensible and effective regulations to address the concerns of all interested parties.

3-D HYDROGEOLOGIC MAPPING IN MCHENRY COUNTY

A 3-D geologic map of McHenry County, Illinois, has been completed and distributed publicly. During this time, ISGS staff, in collaboration with the Illinois State Water Survey, have participated in meetings with local decision makers and have organized public workshops to communicate the findings and demonstrate the value of the 3-D mapping project. The ISGS has also led field trips explaining the local geology and how it has impacted land and water use for local residents, including county and municipal staff, local environmental groups, and elected officials.

In addition to engaging with the public, the ISGS has made the 3-D map, associated software, and explanatory report publicly available for download. To utilize the 3-D map, a user installs the freely available software SubsurfaceViewer® (see below), which was developed specifically for visualization of and interaction with 3-D geologic maps. With this software, the user can explore the surficial and subsurface geology of McHenry County, and more specifically, can explore aquifer distribution throughout the county, by creating custom cross sections, simulated boreholes, and custom maps in any location and at any scale. The 3-D geologic map has been used as the framework for regional groundwater flow modeling, and consultants have utilized it effectively to address possible locations for future municipal water-supply wells.

User interface of SubsurfaceViewer® used to explore the 3-D geology of McHenry County.
The mission of the Indiana Geological Survey (IGS) is to provide unbiased, authoritative, and reliable geologic information to the state’s citizens. The IGS generates and disseminates information about the energy, mineral, and water resources of Indiana, as well as promoting their sustainable use. To accomplish this mission, the Indiana Geological Survey engages in:

- Focused research initiatives and cooperative investigations with governmental agencies, municipalities, businesses and industries, and educational organizations.
- Geologic sample and data collection, archived for continued and future reference.
- Dissemination of information in many forms, including published research, print and digital maps, reports, databases, and educational outreach programs.

These activities fulfill a crucial part of the public service mission of Indiana University (IU) by addressing Indiana’s need for geologic data in light of complex and evolving economic and societal needs. Moreover, it advises, mentors, and employs students to prepare them to be the next generation of earth scientists. Among its many and diverse activities, the following provides a sample of the range and depth of IGS efforts:

**INDIANA SHALLOW GEOTHERMAL MONITORING NETWORK**

The IGS initiated the Indiana Shallow Geothermal Monitoring Network, a test bed for facilitating the optimization of geothermal heat pumps in the Midwest. Shallow geothermal energy represents a renewable resource that can be further developed via ground-source heat pumps. The monitoring network provides in-place measurements of shallow-earth geothermal characteristics. These data reduce costs by allowing designers and installers to make decisions about construction technologies using the specific thermal properties of the geologic materials. IGS scientists were supported through a grant from the Department of Energy Geothermal Technologies Offices, administered by AASG colleagues at the Arizona Geological Survey.

**EARTHQUAKE OUTREACH**

In collaboration with the Indiana Department of Homeland Security (IDHS), the IGS developed the Quake Cottage Program. The Quake Cottage is a mobile earthquake simulator that accommodates four individuals at a time, in which they are exposed to the shaking felt during earthquakes having magnitudes of 3.0 to 7.0. Using an earthquake simulator to provide a realistic, yet safe, experience, certainly raises awareness related to the dangers of earthquakes. This experience also includes instruction on the science of earthquakes and the steps necessary to prepare for such an event. In its first two years of operation, the IGS hosted 82 events statewide, and over 11,000 people came away with a heightened sense of earthquake awareness. The IDHS has just provided funds a third year of Quake Cottage experiences.

**INDIANA MAP AND IGS MAP**

The IGS continues to work with its many partners and data contributors managing and hosting IndianaMap, one of the nation’s leading state-based Web-hosted geographic information systems. It consists of more than 260 layers of data, ranging from energy and mineral resources to land use, infrastructure, environment, biology, geology, and natural hazards—information essential for Indiana’s economic development. The leading achievement of 2014 was the addition of complete LiDAR (for Light Detection And Ranging) and high resolution aerial imagery coverage for the entire state.

Until this year, Indiana’s statewide elevation coverage was provided primarily through the USGS, which, for nearly a century, produced a popular topographic 7.5-minute quadrangle map series in a convenient printed format at a scale of 1:24,000 (1 inch on the map representing 2,000 feet on the ground). On Indiana maps, contour intervals typically are 10 feet. The new high-resolution elevation LiDAR dataset for Indiana permits much greater positional accuracy and contour intervals of 2 feet. The elevation of the points showing the bare Earth can be used to derive a digital elevation model (DEM).

What is remarkable about the LiDAR data for Indiana is the elevation resolution: It is about 7 inches (18.5 cm). Previous DEMs for Indiana, which were produced using the best available technology at the time, were 100-foot (30-meter) and 30-foot (10-meter) DEMs. Hence the resolution in the accuracy of elevations continues to markedly improve with each technological advance.

Statewide coverage of this nature is unusual, and few states in the nation have it. In Indiana, the data were obtained over a three-year period from 2011 through 2013. For this coverage to be possible and affordable, the elevation data were being collected sequentially in successive years in three north-to-south swaths, beginning first with the central part of the state (2011), the eastern part (2012), and finally, the western part (2013). In addition to digital elevation data, a separate aircraft gathered high-resolution color orthophotography with a resolution of 12 inches; the option was also available for counties and cities to purchase 6-inch or even 3-inch resolution imagery. For the aerial photographs to be most useful and the LiDAR to be most accurate, they are collected after winter snow had melted and before the leaves emerged on trees. Consequently, the state was “flown in a leaf-off mode” in March or April.

Complete aerial photographic and LiDAR coverage for the entire state is understandably expensive. Moreover, ensuring that the coverage is total and of sufficiently high quality is a time-consuming process. Nevertheless, through a partnership involving many state and federal agencies and some private sponsors, the three-year $4.6 million project came to fruition. The coordination of the resources available for the funding, the data collection, quality control, and delivery of the data were provided by the State Geographic Information Office and the Indiana Geographic Information Council, a nonprofit partnership composed of state, municipal, local, federal, business, and
private members interested in the use of geospatial data. When the final photographic imagery and elevation data were delivered in December 2013, coverage of Indiana’s 36,000 square miles was made freely available over the Internet to everyone on IndianaMap [maps.indiana.org].

At the IGS, LIDAR data are providing investigators an entirely new look at the Earth, very much like putting on a strong pair of glasses and seeing surface details sharply for the first time. Bare-earth images allow mappers to trace faults and define karst areas where they were once obscured by vegetation. Similarly, areas of past (and possibly future) landslides are revealed through geomorphic analysis of steep slopes. Likewise, subtle variations in elevations along river and stream channels show where water flowed and sediments were deposited in the recent past. Most importantly, LIDAR DEMs display the geology of the state in a whole new format: Differences in rock strata are detected through the integration of LIDAR intensity and elevation data. This means that the geologic mappers of Indiana have a much firmer impression of the geology before they even begin their observations in the field.

In addition to the IGS managing and contributing data layers to IndianaMap, the IGS has initiated a geologically themed version using the same technology called IGSMap. IGSMap is the public source for geologic maps and data in the state. The Map Gallery helps people find commonly used maps and information for a better understanding of Indiana’s geologic materials, resources, and issues. Thematic maps are added to the Map Gallery on a continuing basis.

GEOLOGIC MAPPING

Continued geologic mapping of Indiana at appropriate scales, where such information will be immediately used to protect surface and groundwater from contamination, plan transportation corridors and infrastructure, identify geologic hazards, and sustainably develop the state’s mineral, energy, and water resources.

KANSAS

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The Kansas Geological Survey (KGS), a research and service division of the University of Kansas, is charged by statute with studying and providing information on the state’s geologic resources. The KGS has no regulatory authority and does not take positions on natural resource issues.

Research at the KGS focuses primarily on energy, water, and the environment and addresses natural resource challenges facing the state of Kansas. The KGS also generates new information about the state’s geology and develops tools and techniques for studying the surface and subsurface through its geophysics and mapping programs. Primary users of this information include other state, local, and federal entities, such as the Kansas Water Office, the Kansas Corporation Commission, and the state’s groundwater management districts; oil and gas exploration companies; companies and consultants dealing with construction, environmental, and geologic hazard issues; and educators, private citizens, and others wanting basic information about the state’s geology and resources.

The KGS main headquarters is in Lawrence on the west campus of the University of Kansas, and the KGS Well Sample Library is in Wichita. With a staff of 71 permanent employees and about 31 student employees, including 13 graduate research assistants, the KGS has an annual state-appropriated budget of approximately $5.9 million. Another $2 million in grants and contracts was awarded in fiscal year 2014. The KGS reports to the Vice Chancellor for Research at the University of Kansas and has a 12-member advisory council to provide review and guidance.

The following summary provides an overview of major research projects, services, staff accomplishments, and publications at the KGS during the 2014 fiscal year. For more information on these and other KGS research initiatives and publications, go to [www.kgs.ku.edu](http://www.kgs.ku.edu).

ENERGY

The KGS Energy Research section monitored and addressed exploration and development issues related to horizontal drilling and hydraulic fracturing activities through research and presentations. Horizontal drilling in the Mississippian limestone play continued in south-central Kansas at a fairly constant rate and horizontal drilling in the Mississippian and other pay zones elsewhere in the western half of Kansas declined. The KGS also continued to study and monitor the production of coalbed methane in southeastern Kansas, which continued to fall as gas prices remained low.
The KGS’s multi-year CO₂ sequestration and enhanced oil recovery project continued, including work at the Wellington Field in Sumner County in south-central Kansas. Ten regional sites were selected in southern Kansas for large-scale CO₂ storage in the Arbuckle saline aquifer. A regional assessment of the CO₂ storage capacity was completed and the KGS awaited permission from DOE, which provided funding, to begin fieldwork in the fall of 2014. Injection of CO₂ at the Wellington Field for enhanced oil recovery is planned for the spring 2015, and injection for sequestration into the underlying Arbuckle saline aquifer will follow.

In another multi-year project with DOE funding, KGS researchers are evaluating results from a horizontal well that targeted subsurface features identified at the Bemis-Shutts field using a newly proposed, 3-D seismic imaging technique. Project aims are to validate seismic imaging techniques to assess whether the Arbuckle Group can permanently hold injected CO₂.

Since 2009, the KGS has received nearly $21.5 million in cooperative agreement funding from DOE’s National Energy Technology Laboratory to study CO₂ sequestration. Several government and industry partners have also provided cost-share contributions. Updates on the progress of the CO₂ project are posted on the KGS website.

The KGS’s index well program, which generates regularly updated data on water levels in select western Kansas wells, began in 2007 with the installation of three transducer-equipped monitoring wells. In cooperation with the USGS in August 2013, telemetry equipment was installed in four existing wells that were added to the network in 2012 along the Kansas-Oklahoma line. The network of wells provides data on groundwater declines and remaining water in the High Plains aquifer and focuses on developing methods to evaluate management strategies at the local (subunit) level. Real-time water-level data from the three original monitoring wells are provided through the “Kansas High Plains Aquifer Atlas” on the KGS website to development of online methods of reporting information about newly drilled water wells to the State of Kansas.

**WATER**

The KGS continues to investigate groundwater declines in the High Plains aquifer. In January 2014, the KGS and Kansas Department of Agriculture’s Division of Water Resources measured water levels in about 1,400 wells in western and central Kansas as part of their annual monitoring program.

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**Average 2012 - 2014 Saturated Thickness, Kansas High Plains Aquifer**

![Average 2012 - 2014 Saturated Thickness, Kansas High Plains Aquifer](image)

**Average saturated thickness map from the online Kansas High Plains Aquifer Atlas.**

![Average saturated thickness map from the online Kansas High Plains Aquifer Atlas.](image)
increase public awareness. The atlas features more than 70 maps showing water levels, irrigation, land cover, water rights and use, and climatic trends and can be accessed at http://www.kgs.ku.edu/HighPlains/HPA_Atlas/index.html. It is updated as new information becomes available.

The KGS is developing a model of the High Plains aquifer in west-central Kansas (Groundwater Management District #1). The model will be used by GMD1 and Kansas water agencies to assess the impact of pumping reductions on groundwater availability in that portion of the aquifer. The KGS maintains the Kansas Master Groundwater Well Inventory (MWI), a central repository that imports and links together the state’s primary groundwater well data sets.

With funding from DOE, the KGS studied the integrated use of surface and subsurface Nuclear Magnetic Resonance (NMR) for measuring and mapping saturated hydraulic conductivity in three dimensions. The USGS helped fund a study on aquifer storage and recovery in near-surface aquifers through the development of a new recharge approach using small-diameter low-cost wells. The KGS also continued work with Michigan State University and others as part of an NSF-funded study of the High Plains aquifer.

A range of water-level and water-well information is available through the KGS website and the Data Resources Library in Lawrence.

**GEOLOGY**

The KGS continued work dedicated to advancing scientific understanding of the sedimentary facies, stratigraphic framework, and chronostratigraphy of the High Plains aquifer system. The project has several sponsors and is multifaceted in scope. Scientific drilling in western Kansas was inaugurated in 2010 with funding provided by the National Science Foundation, Kansas Water Office, and U.S. Geological Survey. To date, 28 long continuous cores totaling over 1,300 meters have been collected from study areas in Haskell, Thomas, Harvey, McPherson, Norton, Scott, and Reno counties, with additional new drilling planned in Meade County. Other research projects focused on Cretaceous and Neogene stratigraphy and paleoclimatology of the Great Plains.

The KGS continues to update and create new county geologic maps, supported, in large part, by the U.S. Geological Survey STATEMAP project. In 2014, the KGS submitted six published quadrangle maps as open file reports to the USGS Geologic Mapping Database of the United States. Two preliminary surficial geology quadrangle maps were submitted for each of the following projects: Haskell County, Jefferson and Atchison counties, and Miami County.

In the summer of 2014, KGS geoarchaeological field investigations, funded by KU’s endowed Odyssey Archaeological Research Program, were conducted in the flood pool of Tuttle Creek Reservoir at the Coffey site in northern Pottawatomie County in search of pre-Clovis cultural deposits. Excavations continued in the Severance Formation, and chipped-stone artifacts were recovered from the upper 70 cm of a buried soil in that stratigraphic unit. Excavation also continued at the Scheuerman mammoth site in Scott County, where the remains of a 15,500-year-old mammoth was unearthed in 2011. At that site, KGS and KU investigators are trying to determine if evidence of tool-making activities and the mammoth, found in proximity to each other and in the same geologic layer, can be linked chronologically.

**GEOPHYSICS**

The KGS seismic-reflection program continued to address engineering and subsidence issues in Kansas and elsewhere with sponsors that included engineering and environmental companies. A grant from the company XRI Geophysics provided funding for a project to improve on technologies used to detect underground voids and faults, to determine the fitness of earth dams and levees, and in other endeavors using seismic-imaging technologies conceived and developed at the KGS since the late 1990s.

**INFORMATION DISSEMINATION**

The Kansas Data Access and Support Center (DASC)—located at the KGS and operating under the direction of the Kansas GIS Policy Board and Kansas GIS Director—serves as the geospatial data clearinghouse for the state. DASC works with KGS geologists, and the DASC database includes Kansas GIS data on water, energy, and environmental resources.

Oil and gas production, water-level, and water-well data are available on the KGS website under the “Energy” and “Water” headings.

The KGS continued its successful annual Kansas Field Conference, undertaken since 1995 to give state legislators and other decision-makers a first-hand view of the state and its natural resources. In June 2014, the Conference was held in central Kansas and the Arkansas River valley. Among the issues addressed were surface-water rights, water diversion, and wetlands management; air quality standards; sorghum markets, water use, and ethanol production; oil field treating chemicals and oil refining; harmful algal blooms; and short-line industrial rail transportation. The Kansas Department of Wildlife, Parks, and Tourism, the Kansas Water Office, and the Kansas Department of Transportation were co-sponsors.

HONORS/MILESTONES

- Rex Buchanan, KGS interim director, served as AASG Editor in 2013–14 and Secretary in 2014–15; chaired the state’s induced seismicity task force; co-chaired the Interstate Oil and Gas Compact Commission/Ground Water Protection Council work group on induced seismicity by injection; and represented AASG on the AGI Critical Issues Program Advisory Committee.
- Rolfe Mandel, KGS geoarchaeologist/Quaternary geologist and a faculty member in the University of Kansas Department of Anthropology, was named a KU University Distinguished Professor.
- Evan Franseen, KGS senior scientific fellow, served as president of the Society of Sedimentary Geology (SEPM).
- Greg Ludvigson, KGS senior scientist, served as Councilor for Sedimentology for the Society for Sedimentary Geology (SEPM), and as a Sedimentary Geology Division representative on the Geological Society of America (GSA) Joint Technical Program Committee.
- Jim Butler, KGS senior scientist, served on the Board of Directors of the Scientists and Engineers Division, National Ground Water Association.
- John Doveton, KGS senior scientific fellow, is author of “Principles of Mathematical Petrophysics” published in 2014 by Oxford University Press.

Kansas Field Conference visit to a company that produces oil field chemicals.
The Kentucky Geological Survey (KGS) has investigated the mineral, energy, water resources, and geologic hazards of Kentucky for 176 years. KGS, a research and service unit of the University of Kentucky has offices, laboratory facilities, and a Well Sample and Core Library in Lexington and a Western Kentucky Office in Henderson. KGS staff members provide technical expertise on coal, oil and natural gas, water, industrial minerals, geologic hazards, and geographic information systems (GIS) to Federal, State, regional, and local government agencies, private industry, and the public. They also serve on numerous committees, boards, and professional societies. In 2013–14, the Survey employed 50 full-time staff members, as well as student assistants and temporary employees.

**LEGISLATIVE MANDATES**

**Kentucky Oil and Gas Data Repository**—The repository, established in 1960, includes records of drillers' logs, wireline logs, well-location survey plats, plugging affidavits, stratigraphic tops, and well-completion reports. These records are the most-frequently-searched information by users of the KGS Web pages. The system is accessible at web address: http://www.uky.edu/KGS/emsweb/data/ogdata.html. It now provides access to 654,698 scanned records. The records come from more than 163,884 oil and gas permits issued in Kentucky.

**Kentucky Groundwater Data Repository**—The repository was begun in 1990 to archive and disseminate groundwater data collected by State agencies, independent researchers, and other organizations. It contains more than 92,000 water wells and 5,100 springs, with samples from more than 20,000 of the wells and 2,400 springs. Access is available at this Web site: http://www.uky.edu/KGS/water/research/gwreposit.htm. Data can be searched by county, 7.5-minute quadrangle, or by using a radius from specified latitude and longitude coordinates. The resulting data can be viewed in tables or on an interactive map, and is valuable to anyone interested in water supply and quality.

**Kentucky Interagency Groundwater Monitoring Network**—In 1998, the Kentucky General Assembly directed the Survey to establish a long-term groundwater monitoring network. The network collects groundwater data, characterizes groundwater quality, distributes groundwater information, improves coordination between agencies that use groundwater data, and facilitates data sharing. These activities are conducted in coordination with the Interagency Technical Advisory Committee (ITAC), composed of 15 State and Federal agencies and the University of Kentucky.

Network activities are reported on an annual basis to the governor and legislature. From July 2013 through June 2014, over 20 groundwater investigations and data-collection activities were carried out by Interagency Technical Advisory Committee member agencies. Groundwater and related surface-water information was communicated to the scientific and regulatory communities and to the public through various publications and presentations, as well as postings on websites. References were submitted for entry into this report for 13 groundwater publications, 6 surface water publications, and 26 groundwater presentations at various venues across the state.

**Well Sample and Core Library**—The 48,000-square-foot Well Sample and Core Library contains Kentucky’s only public collection of well samples and rock cores, storing cuttings from about 19,000 oil and gas wells and core samples from more than 3,300 sites. The library provides a service to individuals, universities, and companies needing direct access to samples for research or investigations. During the fiscal year, more than 80 exploration scientists from 15 oil and gas companies examined cores and samples, and researchers requested more than 1,400 samples for geochemical and physical properties testing.

**ENERGY AND MINERALS**

**Geologic sequestration of carbon dioxide**—KGS staff completed well-site activities and continued to analyze data collected from a 4,835-foot-deep stratigraphic research well drilled in April 2013 in the Eastern Kentucky Coal Field. KGS partnered with Hanson Aggregates (a subsidiary of Lehigh Hanson, Inc.) for access to the drill site in northern Carter County. Well testing was conducted in August 2013, and was preceded by sampling formation brines from the Copper Ridge Dolomite and Rose Run Sandstone. This project was initiated as a result of a mandate and funding from the 2007 Kentucky legislature for carbon storage and enhanced oil and gas research. A deep-sequestration research well was also drilled in the Western Kentucky Coal Field in 2009.

**Carbon storage partnerships**—KGS continued research in phase III of the Midwest Regional Carbon Sequestration Partnership funded by the U.S. Department of Energy. This research continues regional characterization of reservoirs and confining intervals, and injection testing in other states to help prepare for future possible commercialization of carbon storage. KGS will continue to work with the partnership’s geologic research team to investigate subsurface geology and refine models for estimating geologic carbon storage options in shales across the region, especially those that have the potential to utilize CO₂ for enhanced oil or gas recovery.

**Utica Shale Appalachian Basin Exploration Consortium**—KGS completed a collaborative five-state study of the geology, stratigraphy, and hydrocarbon potential of the Ordovician Utica Shale, an unconventional gas and oil reservoir in the Appalachian Basin. The research was conducted by KGS staff as well as researchers at the Pennsylvania, Ohio, and West Virginia geological surveys, Washington University, Smith Stratigraphic LLC of New York, and the U.S. Department of Energy’s National Energy Technology Laboratory. The research team at KGS analyzed 1,094 sets of rock samples (well cuttings or core) from project wells for total organic carbon content using a carbon/sulfur analyzer in the KGS laboratory. After the completion of the project, KGS hosted an end-of-project core workshop and an all-day field trip to northern Kentucky.
KGS Minerals Database—A minerals database for Kentucky was completed and made available online at kgs.uky.edu/kgs-map/KGSMINeral after a decade of work. It contains more than 20,000 scanned mining and mineral records, including core logs, cross sections, mine and property maps, geochemical and geophysical maps, chemical analyses, and unpublished reports, particularly from the three major districts in central, southern, and western Kentucky.

WATER RESOURCES
Karst activities — The sinkhole that occurred on February 12, 2014, at the National Corvette Museum in Bowling Green, Ky., captured media and public attention. The sinkhole resulted in a collapse of the museum’s SkyDome exhibit area floor, causing significant damage to the building and eight vintage Corvettes on display. Sinkholes are common features in the karst area around Bowling Green, and are numerous in the vicinity of the museum’s location. In the months following the Corvette Museum sinkhole collapse, Water Resources staff responded to dramatically increased numbers of requests for interviews and information from print and television media, as well as calls and e-mails from concerned homeowners who reported sinkholes on their properties and sought help in assessing the severity of the problem and a remedy.

LiDAR mapping of karst sinkholes—Water Resources staff continued research using LiDAR data and new data-processing methods to improve sinkhole identification and mapping in Kentucky. Sinkholes were mapped in surface watersheds in Bullitt, Jefferson, and Oldham Counties. Results obtained thus far demonstrate that the number of probable sinkholes identified from LiDAR mapping is approximately four times greater than the number identifiable using contoured depressions visible on topographic maps. A field inspection of sinkholes indicates that the LiDAR method is 80 percent successful in identifying new sinkholes in the study area. This research is ongoing, and the objectives are to refine the method and extend the mapping area to other sinkhole areas of the Bluegrass Region of Kentucky.

Watershed study—KGS continued collaborative work with the University of Kentucky College of Agriculture on the Cane Run Basin karst hydrology project. The research is directed at gathering field data needed to measure the discharge of groundwater and potential contaminants such as nitrate, phosphorus, fecal bacteria, and suspended sediments in the karst aquifer beneath the Cane Run surface drainage basin in Fayette and Scott Counties. The data and findings obtained by this project are aiding the College of Agriculture and the Lexington-Fayette Urban County government in designing and implementing best management practices to improve stormwater disposal and water quality in the Cane Run Basin, a tributary of North Elkhorn Creek.

GEOLOGIC MAPPING
Surficial mapping—This year, six new surficial geology 7.5-minute quadrangle maps were produced by KGS mapping staff with the help of funding from the USGS STATEMAP program. Mapping staff also coordinated with the College of Nursing at the University of Kentucky on a project relating to the occurrence of radon and its effects on health. Engineering geologic maps were also developed for the Louisville area to assist with damage assessment from potential earthquakes.

GEOLeGIC Hazards
China Scholarly Exchange and Cooperative Research—This was the tenth year for the exchange of scholars and cooperative research between KGS and several institutes under the China Earthquake Administration. Three KGS staff and a graduate student visited and gave lectures at the Lanzhou Institute of Seismology, Earthquake Administration of Ningxia Province, and Institute of Engineering Mechanics in August 2013. Four visiting scholars from China came to UK to participate in research projects and exchanges.

The Kentucky Seismic and Strong-Motion Network—The 23-station Kentucky Seismic and Strong-motion network monitors earthquakes, mine blasts, and other seismic activities in Kentucky and the central United States. It also records the largest earthquakes from around the world. Near-real-time recordings from 14 of the network seismic stations can be monitored on the KGS website at www.uky.edu/KGS/geologicHazards/equake3.htm. With the addition of strong-motion accelerometers at three real-time stations, near-real-time ground-motion measurements across most of Kentucky can now be made. Also, two more stations were converted from analog to digital data acquisition, increasing the sensitivity of the network to observe smaller earthquakes.

Landslide inventory—KGS staff has been compiling an inventory of the numerous landslide locations in the state and visiting the sites. More than 2,200 locations, including some provided by State government agencies, published maps, field investigations, LiDAR mapping, and reports from the public, have been catalogued. This data was used to create a landslide information map that has been added to the KGS Geologic Map Information Service online, showing the locations of known landslides and areas susceptible to landslides in a geologic and geomorphic context. It provides an overall view of landslide hazards across the state. There are several landslide data layers, represented as points, lines, and polygons.

A landslide in the northeastern part of the Eastern Kentucky Coal Field has been monitored for over a year, to determine the depth, shape, and velocity of the sliding mass, using various tools for a full site characterization. Research work included collection of hydrogeologic data, precipitation, landslide material and strength properties, landslide movement data, and surface and borehole electrical resistivity.
TECHNOLOGY TRANSFER AND PUBLIC OUTREACH

Web services—The KGS website www.uky.edu/KGS serves a diverse and international audience. It provided information about KGS, research projects, Kentucky resources, and geoscience education to 266,000 users from 216 countries during the last year. Overall, there were about 1.2 million hits during the fiscal year. Users most frequently downloaded oil and gas records, online publications, coordinate conversion services, and data from the online geologic map server. Among the improvements and additions during the year was the release of the Coal Resource Information map and data service, with funding from the Kentucky Department for Energy Development and Independence.

Earth Science Week—KGS holds its annual open house during Earth Science Week in October, typically attracting between 170 and 250 students, parents, and teachers. Exhibits and activities are prepared for visitors including energy, minerals, fossils, seismology, mapping, and general geology.

Distinguished Lectures—Each year, KGS sponsors or co-sponsors lectures on geologic topics. Recent speakers have included Joe Stefani, Chevron Energy Technology and Andrew H. Knoll, of the Harvard University Departments of Organismic and Evolutionary Biology and Earth and Planetary Sciences.

Annual Seminar—KGS continues to hold its annual seminar each spring, focusing on geology and public policy topics. The 2014 seminar topic was Monitoring Kentucky: LiDAR and Other Technologies. KGS, state agency, and private company speakers spoke to a crowd of 145 people. This event is the largest gathering of geologists in Kentucky each year.

Major Publications—Eleven new publications were produced by KGS staff during the fiscal year. Among the highlights: Three publications on research from a deep carbon storage well drilled in eastern Kentucky in 2009; an investigation of pavement subsidence in the Cumberland Gap Tunnel; and a review of the 2010 oil and gas production of Kentucky.
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The Louisiana Geological Survey (LGS) was first organized in 1869 and was permanently established by Act 131 of the Louisiana State Legislature in 1934. It was legislatively transferred from the Louisiana Depart- ment Natural Resources to Louisiana State University (LSU) in 1997 and currently reports through the Executive Director of the LSU Center for Energy Studies to the LSU Vice Chancellor of Research and Economic Development.

Geological investigations ongoing at LGS generally reflect its primary mission of promoting environmentally sound economic development of energy, mineral, water and environmental resources of the state. Reports of investigations are provided to the funding sponsors of the project and after approval, are made available to all interested parties. LGS research publications are provided through articles in professional journals, LGS publications and presentations at appropriate technical conferences and other venues as and when needed. Currently, LGS has 14 full time and 2 part time staff including all categories of personnel. Research projects are conducted primarily under four sections:

1. Geologic Mapping and Mineral Resources Section conducts investigations of the Surface Geology of Louisiana and does surface mapping under the federally funded State Map Program managed by the U.S. Geological Survey and produces maps at 1:100,000 and 1:24,000 scales. 2.) The Basin Research Energy Section conducts oil, gas, and coal related research projects. 3.) The Water and Environmental Section currently monitors lake and river water quality and provides data on streams to add to the state’s water database and supports the efforts of the USGS and the Department of Natural Resources for management of the state’s water resources. 4.) The LGS Cartographic Section prepares the final maps and other LGS publications, and does GIS work on research projects. Over the years it has received many major awards for excellence of its products.

**GEOLOGIC MAPPING**

The Louisiana Geological Survey is the only research organization doing geologic mapping in the state of Louisiana. The continuing mapping effort is supported by cooperative agreements with the U.S. Geological Survey (USGS) under the STATEMAP component of the National Cooperative Geologic Mapping Program—proved by the U.S. Congress.

The STATEMAP project for fiscal year 2013-2014 involved geologic mapping and compilation of the final two remaining uncovered 30 X 60 minute quadrangles, Bastrop and Tallulah, in the northeastern corner of the state, completing 1:100,000-scale state coverage with a mix of cartographically prepared lithographs and draft GIS compilations. LGS cooperative agreements with the USGS under the STATEMAP program through fiscal year 2013 have resulted in 25 compilations of 30 X 60 minute geologic quadrangles, 15 of which are published LGS lithographs and 10 of which are open-filed GIS compilations. Another 5 30 X 60 minute geologic quadrangles were produced in-house entirely by LGS or with partial support from other sources.

Since the late 1990s LGS also has prepared 7.5 minute geologic quadrangles at 1:24,000 scale totaling 46 sheets. Thirty-six were prepared with STATEMAP support, and the other ten were prepared for the U.S. Army Corps of Engineers in the Fort Polk region, west-central Louisiana. The fiscal year 2014-2015 STATEMAP project resumes 1:24,000-scale field mapping with three 7.5 minute quadrangles in the Lake Charles area.

A 2-year (2013-2015) project funded by the Louisiana Coastal Protection and Restoration Authority (CPRA) continues in its second year. For the first year, a detailed structural map of the unconformity that forms the base of Holocene sediments within the Louisiana Coastal Zone and report were prepared for its eastern part, which consists of the Mississippi River Delta plain. Work for the second year is focused on preparing a detailed structural map of this unconformity for the entire Louisiana Coastal Zone. This unconformity, which is known as the “Holocene-Pleistocene surface,” is a critical geologic feature because the overlying thickness of typically under-consolidated Holocene sediments is a major factor governing local subsidence rates and depth to solid sediments for the foundation of major structures.

**PRESERVATION POTENTIAL OF PREHISTORIC CULTURAL RESOURCES AND SAND RESOURCES**

The LGS is finishing work on “Late Quaternary Stream and Estuarine Systems to Holocene Sea Level Rise on the OCS Louisiana and Mississippi: Preservation Potential of Prehistoric Cultural Resources and Sand Resources” for a cooperative agreement from the Bureau of Ocean Energy Management (BOEM), Bureau of Safety and Environmental Enforcement (BSEE) to investigate possible sand resources and possible archeological sites in the Louisiana state waters in the Outer Continental Shelf. It is examining the responses of Late Quaternary stream and estuarine systems to Holocene sea level rise on the Outer Continental Shelf.
arine systems to Holocene sea level rise. It has so far developed a geophysical and geologic database for the study area. This database contains over 118 offshore hazards maps, boring data, and seismic track line locations. This data is currently being used to develop geologic/stratigraphic models and predictive models for paleo-landscape preservation potential for the evaluation of sand resources of paleo-fluvial channel fills within the study area. An understanding of these processes should result in the evaluation and refinement of models used to predict cultural and non-fuel mineral resources within the offshore continental shelf. A fully functional Geo- graphic Information System (GIS) will be developed from all collected geospatial data.

**GEOLOGIC REVIEW**

This project is a continuing program which began in 1982 and provides regulatory technical assistance to the Coastal Management Division of the Louisiana Department of Natural Resources and the U.S. Army Corps of Engineers (USACE) and is renewed every year. The purpose of this program is to review drilling permit applications in Louisiana’s coastal zone to avoid and/or minimize environmental damage to the wetlands by proposing alternate concepts like reducing the size of ring levees and slips, reducing lengths of board roads and canals, directional drilling and potential use of alternate access routes. This has been a very successful program and is, as far as we know, the only one of its kind in the country.

**SURFACE WATER GAGING NETWORK IMPROVEMENTS**

LGS received a three year contract (2012–2015) from the Louisiana Department of Natural Resources (LDNR) titled “Surface Water Gaging Network Improvements”. The main objective of this project is to provide additional data to supplement efforts to monitor and manage surface and groundwater resources being conducted by the USGS for DNR. During the first two years of the project, fifty gaging stations were selected for discharge measurements and data so obtained was used to develop new rating curves and profiles or revise them if there was existing data. Four new surface gaging sites were also established where there were none. Further, LGS compiled hydrologic and geologic data for publicly owned reservoirs and lakes from existing records. During the second and third years of the project, the monitoring work will be continued and the data will be kept updated and revised as needed.

**NATURAL COAL RESOURCES DATA SYSTEM (NCRDS)**

Louisiana Geological Survey is investigating the occurrence of coal in Louisiana and its potential for exploitation as an economically significant source of natural gas. The current effort, begun in 2010 under contract with the U.S. Geological Survey as part of the National Coal Resource Data System, focuses on the distribution and abundance of coal seams in the Paleocene-Eocene Wilcox group confined to the subsurface in the northern half of the state (north of the 31st parallel). This study has produced stratigraphic correlation cross-sections depicting modern subsurface structure over a comprehensive set of N-S and W-E traverses. Information from these cross sections combined with data from additional well logs yielded a set of structural contour maps for the upper and basal contact surfaces of Wilcox. During 2012–2013 selected well logs were analyzed to correlate coal seams to stratigraphic horizons in Wilcox and to produce isopach maps of coal for the entire study area. Narrative text crafted in 2014–2015 will be combined with revised and updated maps and cross-sections for a final report to be submitted at the close of fiscal year 2015.

**INVENTORY AND DIGITAL INFRASTRUCTURE OF HISTORIC LOUISIANA GEOLOGIC MAPS, PUBLICATIONS, AND OTHER DATA**

Thousands of published and unpublished geologic maps, cross-sections, sample site maps, petroleum mapping and other geo-data dating back to the 1870s exist in Louisiana Geological Survey (LGS) cartographic storage rooms. The material consists of lithographic prints, working drafts, historic reference maps, and many original manuscripts on linen, vellum, positive and negative film, contact prints, and even some metal plates. Much of this data is from publications long out of print and some are unpublished manuscripts unknown to the re-search community. An estimated 6,000 map sheets are involved. This material has been kept in climate-controlled rooms, but it has been moved many times over the decades and original inventories have not survived. The current project is to continue an effort begun in 2010 to systematically inventory and catalog the extensive LGS cartographic repository of historic maps, cross-sections, and other geologic and topographic data. All documents in tube rack storage were completed in 2010 and all documents in fireproof vertical cabinets were completed in a 2011 project. This year the map documents that reside in over 40 flat map filing cabinets were processed. The project also selected candidates for digital archiving based on the inventory database. Paper and film documents were converted to high-resolution digital formats, stored on permanent media, and metadata records were prepared for entry into the National Digital Catalog. A relational database was created to index the material. The project will result in vastly improved accessibility of the LGS cartographic archival material for LGS research, the geologic research community, and the general public.

*LGS staff conducting a Flow Tracker® survey of Beaver Bayou near Wax Road in Baton Rouge, Louisiana on June 20, 2013.*
EVALUATION OF WATER PERMIT REQUESTS

LGS provides the Louisiana Department of Natural Resources with unbiased recommendation of water permit requests. These requests are received by LDNR from other state agencies, parish governments, etc., and are sent to LDNR mainly to evaluate environmental consequences resulting from the action proposed.

PRELIMINARY GEOLOGIC ASSESSMENT AND ECONOMIC ANALYSIS OF LOUISIANA’S SAND RESOURCES

LGS conducted a preliminary study of sand resources in four areas to determine its suitability for use as proppant in hydraulic fracturing and to assess its potential for economic development. Samples were collected in the Catahoula sandstone near Sicily Island and from the Amite River Basin. After laboratory analysis, it appeared that all the samples analyzed were on the borderline of acceptance for use as proppant. Initial findings of this study were also reported in the AAPG Explorer (September 2014) in an article by Louise Durham titled “Getting Down to the Nitty Gritty of Fracturing.” LGS intends to expand this initial study into a statewide investigation subject to the availability of funds.

LOUISIANA’S POTENTIAL FOR UNCONVENTIONAL ENERGY RESOURCES

The last major LGS study on unconventional shale energy resources was completed in 1997 and the results were published in the Basin Research Institute (now part of LGS) bulletin in the following paper: John, C.J., B.L. Jones, J.E. Moncrief, Reed Bourgeois and Brian J. Harder, 1997: An Unproven Unconventional Seven Billion Barrel Oil Resource—the Tuscaloosa Marine Shale: Basin Research Bulletin, Louisiana State University, v.7, August, pp.3–23.

As is now well known, the Tuscaloosa Marine Shale (TMS) has become an active major oil play covering parts of Louisiana and Mississippi with many completed successful oil wells. This LGS paper remains a landmark reference for the continuing commercial development of the TMS.

Similarly, the geopressured-geothermal unconventional resources of the Gulf Coast represent a future major energy resource when the technology is developed and the economics of commercial development become profitable and feasible. LGS was a participant in the US Department of Energy, Gulf Coast Study on this topic (1975-1992) and a contributor of temperature and geologic data to the National Geothermal Data System (NGDS) project. These projects have provided critical data and information needed for the commercial development of this unconventional resource over time. LGS plans to initiate a statewide investigation to evaluate the existence of unconventional potential shale gas/oil plays, including bypassed oil/gas sources and are currently looking for funding sources to undertake this project.

Rock’n In The Swamp—LGS participated in “Rock’n in the Swamp,” a one-day educational outreach event for schools organized by Baton Rouge Parks and Recreation which was held on March 8, 2013. The LGS exhibit booth displayed rocks and minerals found in Louisiana and other places and thin sections. Fossils specimens were also displayed. The LGS booth proved to be one of the star attractions for the hundreds of school students and adults attending the event. The event also featured gem and mineral vendor booths and natural science exhibits.

OUTREACH ACTIVITIES

Earth Science Week—Earth Science Week is sponsored annual by the American Geosciences Institute (AGI) and its member societies. At the request of the LGS, Governor Jindal issued a proclamation declaring October 13–19, 2013 as Earth Science Week in Louisiana. The theme for the week was “Mapping Our World.” LGS received 50 educational kits from AGI which were distributed to school earth science teachers through the program coordinator of the East Baton Rouge Parish School System.
LGS Resource Center—The LGS Resource Center consists of a core repository and log library. The core and log collections are included as part of the LSU Museum of Natural History as defined by the Louisiana Legislature and is the only one of its kind in Louisiana. The core facility has more than 30,000 feet of core from wells mostly in Louisiana. The well log library contains more than 50,000 well logs from various parishes in the state. The LGS Resource Center is available for use by industry, academia and government agencies, and others who may be interested. There is a nominal daily charge for use of this facility. Contact the LGS office to schedule a visit.

Geologic information is fundamental to social, economic, and environmental applications in Maine. Water and mineral resource distribution, their qualities, and consequences of their use and misuse can be better understood with geological information. The Maine Geological Survey (MGS) has active programs that our customers and we believe will provide the greatest benefits to the citizens of Maine. These benefits can be defined as promoting a sound understanding of the state’s geological resources and their appropriate use while safeguarding the environment.

Our mission statement reflects the benefits of geological investigations to society, The mission of the Maine Geological Survey is to provide the people of Maine with quality information to facilitate informed decision-making for natural resource management, economic development, conservation planning, and regulation; to provide public assistance; and to promote education. The MGS maps, inventories, assesses, and interprets Maine’s geology and supports its mission by using computerized geographic information systems and databases, and by publishing maps and reports.

Geology has played an important role in the development of the state. In the eighteenth and nineteenth centuries, minerals were extracted along the coast to provide raw materials for manufacturing of all types. Lime was mined and fired in kilns as an agricultural amendment. Granite and slate were quarried to provide the basic building blocks of modern civilization. Early geological surveys of the state by C.T. Jackson in 1837 and C.H. Hitchcock in 1885 emphasized these critical mineral resources and their geologic settings. Since those early days, the significance of geology to society has broadened. Programs of the Maine Geological Survey reflect this broad application of geology to societal issues:

- The Bedrock and Surficial Geology program provides basic geologic mapping and interpretation of surficial materials and bedrock mapping and interpretation of rock types and structures. This basic geologic mapping is the foundation for the evaluation, appraisal and inventory of specific physical resources, mineral occurrences, and geologic hazards in the state.

- The Hydrogeology program assesses ground and surface water conditions, emphasizing ground water quality and quantity, and the protection and wise use of the State’s ground water resources.

- The Marine Geology program conducts research on the geological setting of the coast and near-shore submarine environment and provides technical services to other state agencies involved in the coastal zone. Research and mapping is conducted for shoreline stability, landslides, sea-level rise, beach nourishment sources, and dredge spoil disposal sites.

- The Publications and Outreach program ensures that the geological information generated by the other programs is made available to a variety of users.

**GEOLOGIC MAPPING**

Slightly more than 700 topographic maps at 1:24,000-scale cover the state. Of this total, the MGS has produced surficial geologic maps for about 170. Preliminary surficial maps at a more generalized scale cover much of the rest of the state. With regard to bedrock maps, there are about 50 completed at the 1:24,000 scale with another 20 in progress. About half of the state is covered with more generalized preliminary bedrock maps. Our STATEMAP program shifted from the Augusta 1:100,000 quadrangle to neighboring areas where our experienced team of staff geologists and contractors could test the validity of the geological models developed through that mapping effort. We
are mapping both the bedrock and surficial geology in the northwestern Penobscot Bay area. This area includes portions of the Norumbega fault zone, a major dextral strike-slip zone that was active in the late Paleozoic and early Mesozoic, and is analogous to the present-day San Andreas. Our earlier mapping in the Augusta area identified localities along the fault zone with both ductile (mylonite) and brittle (pseudotachylyte) features, suggesting the current exposure is in the critical ductile/brittle transition zone that is inaccessible in active fault zones. As a spin-off from our work, this zone is the focus of more detailed study by U Maine researchers through an NSF grant.

Newly acquired LiDAR elevation data for northwestern Penobscot Bay is revolutionizing our ability to map the surficial deposits developed there through complex interactions with the sea by advancing and retreating ice. A remarkable and systematic sequence of end moraines that we interpret as annual retreat positions of the ice margin is revealed in this high resolution coastal dataset. We are recognizing sub-glacially scoured melt-water channels, delicate esker systems, and raised beaches that hold valuable aggregate resources.

Recessional moraines and a Pleistocene shoreline revealed with LiDAR, Penobscot Bay area.

**HYDROGEOLOGY**

We completed our collaborative project with the USGS on the Branch Brook watershed of southern Maine begun in 2010. This watershed is an important water supply for southern coastal communities and was at the center of extensive legislative debate when a water bottling company proposed large-scale water withdrawals there several years ago. The primary water source is complexly layered glacial sediments and the small brook that receives groundwater discharge. With the USGS, we developed a groundwater model that was used to assess the impacts of additional water withdrawals, climate change, and other scenarios on water availability. In particular, this model demonstrated the impacts of water withdrawals on surface water flows under different conditions. We modeled flows with no groundwater pumping, a 25% reduction in precipitation, and increased pumping to 150% of current rate. The greatest impact to stream flows was from the simulated drought condition, but increased pumping also had an impact. The model will help the local water district address in-stream flow regulations.

**Water well database**—Digital compilation of bedrock water-well data continued, including well depth, well yield, and overburden thickness/depth to bedrock. Private drillers provide MGS with reports on these factors for each domestic water well they drill. Our database now contains over 100,000 entries and is a critical element in the analysis of ground water vulnerability. In this year, MGS developed an interactive map application that allows the user to specify an area of interest, well information desired, and extract data for additional analysis. [http://www.maine.gov/dacf/mgs/pubs/digital/well.htm](http://www.maine.gov/dacf/mgs/pubs/digital/well.htm)

**Arsenic and other contaminants**—Arsenic continues to top the list of natural contaminants of concern in Maine groundwater. We continued a multi-year collaboration with Columbia University on a portion of a large proposal, funded by the National Institutes of Health, to study arsenic globally, with components in Maine, Bangladesh, and elsewhere. In previous summers, we worked with scientists from Columbia to collect nearly 2,000 water samples from private wells in the Augusta area. The water was analyzed for arsenic, uranium, and other natural contaminants. This project is benefiting greatly from the geologic framework for the Augusta area based on geologic mapping conducted through several years of STATEMAP funding. Nearly 30% of the well water we sampled exceeds the federal drinking water standard for arsenic (10 ppb), and these are widely distributed among the metasedimentary rocks that underlie the area. Wells with high uranium correlate strongly with granite intrusions.

In the past year we researched the effectiveness of treatment systems and homeowners abilities to keep such systems in good working order. We visited 100 households that had participated in our previous studies and that had indicated they had installed a treatment system. We tested water before and after the treatment system with a field test kit that provided immediate results, which were then reviewed with the homeowner. Twenty of the systems we tested were not functioning, half due to improper maintenance and the other half due to the homeowner installing the wrong type of system for their water quality problem.

We continue to work with Columbia University and the Maine Center for Disease Control to develop outreach materials and incentives that will encourage homeowners to test their private wells.

**Water use**—MGS is compiling information from major water users into a database as part of an effort to better understand supply and demand, and reduce potential water-use conflicts. With eight years of information already collected, the database is proving invaluable to the discussions of water use versus availability. While for the most part there are few conflicts in water use, several watersheds have potential for conflict between in-stream and out-of-stream uses. The greatest challenge this year is to develop a more rigorous method to estimate agricultural irrigation based on acreage in various crops and climate. Our data collection effort is helping focus scant state resources on the areas with the greatest need.
MARINE GEOLOGY

Beach profiling: Since 1998, the MGS has been involved in a beach profiling program that uses local volunteers on about a dozen southern Maine beaches to collect monthly profiles from multiple transects on each beach. This program is funded in cooperation with U Maine and the Maine Sea Grant program. Through this program, MGS and its cooperators are compiling seasonal and long-term information on the health of some of the most economically important beaches of the state. The results of several years of profiling are posted at [http://www.geology.um.maine.edu/beach](http://www.geology.um.maine.edu/beach). Seasonal changes to the beaches are being documented to understand natural cycles and volumes of erosion and accretion. Results of the profiling will be compared to coastal wave and wind data to understand how storms (northeasters, southeasters, tropical storms) affect various beaches in southern Maine.

Potential Hurricane Inundation Mapping—With funding from the Maine Floodplain Management Program through a grant from FEMA, marine geologists created a Potential Hurricane Inundation Map (PHIM) series that can be accessed online. The PHIMs show areas along the Maine coast that might potentially be flooded by storm tides (the combination of a predicted tide and storm surge) under scenarios of Category 1 or 2 storms making landfall at either mean tide or mean high tide. The maps also show an additional 20% potential flooding uncertainty band associated with each scenario. The PHIMs can be used to improve emergency preparedness and planning by helping identify vulnerable critical public infrastructure at the local, county, and state level. The maps were created using the National Hurricane Center’s Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model in addition to newly available highly accurate topographic data of Maine’s coastline.

![Potential Hurricane Inundation Map for the Portland area from a category 1 storm making landfall at mean high tide.](image)

Although the threat in Maine is generally small compared with southern New England states, hurricanes can and do happen in Maine. Due to the colder Gulf of Maine waters and its geographic location, most hurricanes that cross into Maine have made landfall elsewhere and either weakened to tropical storms or become extra-tropical. Since records were started in 1842, only five hurricanes have made landfall along the Maine coastline as either Category 1 or 2 storms; the most recent was Hurricane Bob in 1991. However, many of these events have still caused extensive damage, injuries and even deaths. It is the responsibility of local, regional and state governments to be prepared for and respond to these events, and the PHIM series is meant to help all levels of government achieve that goal.


Sea Level Adaptation—With the Southern Maine Regional Planning Commission, the MGS initiated the Sea Level Adaptation Working Group (SLAWG) for the purposes of developing and implementing regional climate change adaptation strategies, to respond to rising sea levels and to become more resilient to coastal storms. Based on tide gage data during the last century in Portland, sea level rose 7 inches, a rate of nearly 2 millimeters per year. The most recent 20 years suggest a much higher annual rate of rise. The SLAWG includes officials from southern Maine’s coastal communities and from state agencies. Their duties of the group include:

- Identifying infrastructure vulnerable to storms and sea level rise; using regional approaches to plan for improvements.
- Recommending the standardizing of floodplain management standards and building code interpretations across jurisdictions to improve resiliency of individual private structures.
- Recommending standardizing of ordinance review standards affecting shorelands.

In the past year, the SLAWG has made great progress in working with southern Maine communities to address the potential for sea-level rise.
Offshore surveys—Created by the Maine Coastal Program in 2013, the Maine Coastal Mapping Initiative (MCMI) is acquiring critical data about the terrain of the seafloor that will be used by regulatory and planning agencies to maintain marine ecosystems, expand offshore economic opportunities, improve maritime safety and prepare for anticipated environmental changes. The MCMI is a collaboration among state, federal, and non-profit partners, including the Maine Department of Marine Resources, the Maine Department of Transportation, the Maine Coastal Program, the Maine Geological Survey, the University of Maine, the University of New Hampshire, the U.S. Department of the Interior’s Bureau of Ocean Energy Management, the National Oceanic and Atmospheric Administration, and the Biodiversity Research Institute. Topographic and habitat maps have been created for 150 square miles of the seafloor off of Maine’s Midcoast region, and priority areas for future mapping have been identified. During summer 2014, data were collected in federal waters in southern Maine.

HAZARDS

Landslides—With the availability of high-resolution lidar elevation datasets, MGS geologists have looked more closely at landslide features within the part of the state underlain with glacial-marine mud. We were startled to discover many previously unrecognized landslides in some of the most densely populated coastal areas of Maine. During the summer of 2014, we further investigated several of these sites, using seismic refraction to estimate thickness of the mud. Future work will include boring to recover datable organic material, in order to test competing theories that many landslides occurred immediately following deglaciation, or alternatively that such events are widely separated temporally.

Flooding—The Maine Cooperative Snow Survey program, managed by the Maine Geological Survey, provided critical information on water content of the snowpack to emergency responders and forecasters throughout the snowmelt period. Our information helped forecasters refine the timing and extent of flooding possible from the snowpack.

GIS AND PUBLICATIONS

Web pages—Our web pages continue to be very popular. Anchored by our publications list and our “Geologic Site of the Month,” usage continues to grow. The pages include a searchable bibliography of Maine geology with over 7,200 references. http://mapserver.maine.gov/conservation/mgs/mgsmaster.php

Users continue to download more than 6,000 geologic maps and reports each month, eclipsing our hardcopy publication distribution by ten-fold.

GIS update—Through the 1990s and early 2000s, the MGS developed a home-grown, menu-based map production system within our GIS that facilitating the formatting and systemization of map manuscripts into final geologic maps. Over the years, standard GIS functions have replicated many of the tasks we had to develop on our own. In early 2013, the MGS began the lengthy process of upgrading our system to a modern GIS environment and also to a database schema more closely aligned with NCGMP-09. This conversion is largely complete.

PROFESSIONAL, PUBLIC, AND EDUCATIONAL OUTREACH

As part of Earth Science Week, we organized “Earth Science Day” at the Maine State Museum. In 2013 about 1,200 middle and high school students attended this popular event which highlighted special displays on Maine minerals and fossils, water resources, gemstones and gem cutting, Maine granites, soils, and mineral collecting. This event is the anchor for our Earth Science Week activities each year.

GOVERNMENT REORGANIZATION

The departmental merger begun in 2012 to create the Department of Agriculture, Conservation, and Forestry is now complete. In addition to managing the Maine Geological Survey, the State Geologist now directs the Bureau of Resource Information and Land Use Planning, a somewhat eclectic collection of programs that did not fit into the three other bureaus of the Department. This Bureau of other programs includes MGS, the Maine Coastal Program, the Maine Floodplain Management Program, the Maine Natural Areas Program, the Land Use Planning Commission, Municipal Planning Assistance Program, and the Land for Maine's Future Program. In 2013-2014 we began developing synergies among the various programs, for example, with a project on sea-level rise impacts at coastal state parks that involves, MGS, the Maine Coastal Program, the Maine Floodplain Management Program, the Municipal Planning Assistance Program, and the Maine Bureau of Parks and Lands. Additional multi-program projects are in various stages of development and execution.
The Maryland Geological Survey (MGS) was founded in 1896 as an independent agency of the state housed at The Johns Hopkins University, with primary responsibilities to:

- Conduct topographic, geologic, hydrographic, and geophysical surveys.
- Prepare topographic, geologic, and other types of maps to meet specific needs.
- Prepare reports on the extent and character of the geology, minerals, and water resources.
- Periodically assess the paleontological resources of the State and coordinate the assessment with interested persons and public agencies.

These responsibilities are still incorporated into the Code of Maryland Regulations, although some of the activities such as assessing the State’s paleontological resources are functions no longer performed. Since 1969, the Survey was incorporated into the Department of Natural Resources and many of the activities and functions that the Survey carries out are conducted to support the management activities of the larger Department. In addition, particularly with regard to ground water studies, the Survey conducts studies in support of the Maryland Department of the Environment’s regulatory control over ground water quality and quantity and for improving understanding the quality of the state’s ground water resources.

Currently, staffing levels are 17 professional, 1 professional contractual, 2 full-time support, and 1 part-time support. Two professional positions were vacated during the year. One has been filled, and the other is currently in the process of being filled. Hiring new professional staff has injected some youth and enthusiasm into the Survey’s ranks, and being permitted to fill the vacant positions during difficult fiscal times indicates the degree of support for the Survey’s activities within the larger Department.

In 2008, The Advisory Committee on the Management and Protection of the State’s Water Resources identified the need for a comprehensive assessment of groundwater resources throughout the state. Rapid population growth and the attendant water demands are putting increasing stress on water resources which had previously been largely taken for granted in a state with relatively high rainfall rates. In cooperation with the Maryland Department of the Environment and the U.S. Geological Survey Maryland-Delaware-DC Water Science Center, MGS has benefitted from the renewed focus on water supply and groundwater studies. Work is continuing on developing a regional groundwater flow model of the Coastal Plain aquifers located south and east of the Baltimore-Washington Corridor, and on gaining understanding of groundwater hydrogeology in the fractured rock areas of the state to the west.

As part of the studies on the Coastal Plain aquifers, the Survey published a Report of Investigations describing and documenting the aquifers and confining units in the Maryland Coastal Plain. The report provides the documentation for the Maryland Coastal Plain Aquifer Information System (MCPAIS), which is currently being used by Maryland Department of the Environment for regulating new uses of groundwater. The MCPAIS functions as an “electronic filing cabinet” for hydrogeologic data used in evaluating groundwater appropriation permit applications in the Maryland Coastal Plain. The system includes surfaces for 29 aquifers and confining units, geophysical logs, water-appropriation and pump-test data, water-level and water-quality data, as well as other information.

MGS conducted an investigation of the Patuxent aquifer in the Waldorf area of Charles County. Four exploratory wells were drilled to depths as much as 2,000 feet to evaluate the water-bearing characteristics of the Patuxent aquifer, which is the deepest aquifer in the Coastal Plain. Because of the aquifer’s depth, the Patuxent aquifer has not been evaluated as fully as the shallower Patapsco and Magothy aquifers, where water-level declines have been documented.

MGS personnel are involved in collecting annual water-level data from more than 450 wells in Maryland (mostly in the Coastal Plain). These data provide information on long-term changes in groundwater levels and are used to identify areas where lowered water levels may indicate the need for alternative water-withdrawal strategies.

The Maryland Ground Water Quality Monitoring Network is an ongoing effort intended to document the chemical quality conditions of Maryland aquifers. In 2012, 2013, and 2014, the Survey conducted a study of methane concentrations in drinking-water wells in the Appalachian Plateau province of Maryland, which includes all of Garrett County and the western
edge of Allegany County. This area is considered prospective for development of the Marcellus Shale. This investigation is intended to provide information on the range of methane concentrations in well water, and also on regional patterns of distribution (wells located in coal versus non-coal areas, and valley versus upland wells). While no gas well drilling permits have been issued at this time, the effort will supply baseline information in advance of any drilling. Currently, Governor O’Malley has established a task force to evaluate the benefits and costs of drilling in the Marcellus and no permits are being issued until the task force has completed its work, expected in early 2015.

MGS installed 7 observation wells at three locations in Garrett County. These wells are providing detailed information on the nature of groundwater flow, water quality, and relation between shallow and deep parts of the sedimentary aquifers in the area underlain by the Marcellus Shale. The U.S. Geological Survey has installed stream gages close to these well sites that allow observation of groundwater/surface-water interaction.

MGS personnel continue evaluating groundwater quality with respect to drinking-water standards. In 2014, MGS conducted a preliminary assessment of radioactivity in the Potomac Group aquifers in Charles County, where polonium has been detected in several public water-supply wells.

Mapping of sinkhole geohazards in the Hagerstown Valley was completed in 2014. Funding from the State Highway Administration and the USGS StateMap program funded a multi-year program which detailed the geology of this region and potential hazards present from sinkhole development and collapse in the Great Valley.

New funding from a USGS StateMap grant was secured to start mapping of the natural gas-bearing areas in Garrett County. Initial work was started in the Accident gas storage field with the goal of defining subtle geologic structures which control the movement of gas and groundwater in western Maryland. This information is important to the planning and management of energy and water resources in this growing region.

Bottom habitat mapping in the Chesapeake Bay and off the Atlantic Coast of Maryland continues to be a major area of interest in support of the DNR-Fisheries Administration and the Chesapeake and Coastal Services planning group. While the ongoing DNR effort to manage and restore the native oyster _Crassostrea virginica_ is a strategic goal, there was a loss of funding for necessary field work in 2014. In 2013 over 19,600 acres of oyster habitat were mapped and characterized, but no surveys were possible in 2014 due to this funding gap. The critical information generated by these surveys locates areas suitable for oyster reef substrate placement or restoration, and potential fossil oyster shell deposits.

MGS Bottom mapping efforts shifted to the Atlantic seafloor in 2014, with projects defining ocean floor sediment condition in state and federal water. Maryland Energy Administration funded an analysis of seabed substrate in Maryland waters off the Fenwick and Assateague shore. Over 107 square miles of in-state seafloor was characterized. This work is part of a larger effort to assess seafloor conditions in proposed offshore wind energy areas. This work continues in 2015 to include previously unmapped areas in federal water adjacent to wind energy lease areas. The U.S Bureau of Ocean Energy Management is also funding a 2-year effort to characterize mineral resources in these same areas.

Sediment management in Maryland’s non-tidal surface waters is of increasing interest to local resource managers and communities, especially in light of the regional focus on reducing sediment loading to the Chesapeake Bay. MGS personnel are applying the same techniques developed to study sediment transport and deposition in tidal waters to assist in answering questions related to proposed dam removals, and sediment accumulation in reservoirs and recreational lakes. Acoustic surveying techniques including side-scan sonar and sub-bottom profiling provides critical information for locating and collecting cores of accumulated sediments. Textural and chemical analyses of the collected materials are central to environmental assessments preceding dam removals including potential sediment delivery and associated contaminants.

This year MGS investigated the existing bathymetry and bottom topography of the Susquehanna River behind the Conowingo Dam. That mapping effort was part of a multi-partner study of sediment accumulation behind the dam, and will be used for a sediment management plan being developed by Exelon Energy. A similar survey of the impounded Potomac River at Cumberland was funded by a contract from American Rivers. Part of a dam removal study, the Cumberland Dam mapping project detailed sediment accumulation behind the dam, and provided sediment samples for contamination analysis.

Maintaining the shipping channels leading to the Port of Baltimore generates approximately 3.5 million cubic yards of dredged sediment every year, for which suitable placement sites...
are needed. MGS staff provides support to the Port by serving on a number of committees and management groups that are part of the state’s ongoing 20 Year Dredged Material Management Plan. This working relationship ensures that the scientific information related to sediment transport and deposition processes is fully incorporated into the management decisions regarding locating and developing suitable placement sites. In addition, MGS has ongoing monitoring programs at existing sites including sediment monitoring and groundwater monitoring. The monitoring efforts and studies result in five or more publications per year provided to the Port and other state resource agencies.

With funding from Chesapeake and Coastal Service, MGS is updating tidewater shoreline change maps and data. Currently available data are over 20 years old and no longer reflect current conditions and trends. The new mapping will employ the most up-to-date available shorelines from NOAA and other sources, and calculate change rates at user-selected intervals and areas. The initial shorelines evaluated are in Anne Arundel and Baltimore Counties, with Calvert and Prince Georges Counties scheduled in the near future. The data will eventually be available through an internet interface.

The Survey continues to participate in the National Geological and Geophysical Data Preservation Program and is currently creating metadata for a portion of its collection of historical aerial photography, with a focus on approximately 4,000 photographs obtained during the two earliest time periods represented in the collection, 1936–1938 and 1951–1953. Scanning will continue on 3,000 air photos flown in 1937–1938 or 1952–1953. In the coming year, the Survey will create metadata for the post-1953 aerial photographs and to begin to scan photos from the two earliest eras. In addition to data preservation activities tied to NGGDPP grants, MGS has been collaborating with the Maryland State Archives (MGS) and the Johns Hopkins University (JHU) library to scan collections of MGS-produced historical maps. The collaborative effort grew out of the formation of the data preservation advisory panel specified in the NGGDPP request for proposals, and has generated significant interest among the involved parties and other libraries throughout the state.
The Massachusetts Geological Survey (MGS) is housed in the Department of Geosciences at the University of Massachusetts Amherst campus. The State Geologist reports to the Vice Chancellor for Research and Engagement. The mission of the Survey is to serve the needs of state government, industry and the citizens of the Commonwealth of Massachusetts by providing earth science information and research relevant to natural resources, environmental quality, economic vitality and public safety. Statutory authority for the Survey is in the Massachusetts General Laws Chapter 21A, Section 7B.

The MGS remains a “soft money” organization hiring post-docs, research fellows, graduate students, undergraduates and contractors, as needed, to complete project work. The Survey receives no funding from the state. We have no support staff. The state geologist is the only state-funded position. Currently, we have one benefited senior research fellow who is the lead for our geologic mapping program, and a post-doctoral fellow who is funded 75% for the next 2 years and will work on several projects.

**GEOLOGIC MAPPING**

Approximately 36% of all grant funding secured by MGS is for geologic mapping, most of which comes from the NCGMP. We continue to work through STATEMAP on updating older and outdated bedrock geologic maps focusing on the eastern portion of the state where development and stresses on water and other resources are greatest. We have completed or open-filed nearly 40 quadrangles covering portions of all 9 U.S. Congressional Districts and 9 counties. The Survey is also cooperating with the USGS on completing publication of surficial geologic maps for all 189 quadrangles in the state. This has been a major effort by the USGS under the FEDMAP program and the project is about 75% complete. Dr. Yvette Kuiper from the Colorado School of Mines has been working with students in the Nashoba Terrane in the eastern part of the state and students from Salem State University have also been active under the supervision of Dr. Lindley Hanson. We continue to collaborate with other retired faculty on legacy mapping and acknowledge Drs. Peter Robinson, Meg Thompson and Chris Hepburn for their assistance.

Last year we completed two maps as part of STATEMAP: a "Preliminary Working Draft of the Bedrock Geology of the Clinton Quadrangle, Worcester County, Massachusetts" and a "Progress Map of the Onshore-Offshore Surficial Geologic Map of the North Truro Quadrangle, Barnstable County, Massachusetts". Three mapping projects are currently underway with STATEMAP funding from FY14.

**ENVIRONMENTAL GEOLOGY AND HAZARDS**

Recent disaster declarations from ice storms, rain events, tornadoes and tropical storms in Massachusetts have provided some opportunities for funding under the 5% initiative in the FEMA Hazard Mitigation Grant Program (HMGP). This year, we completed one project with FEMA funding. Tropical Storm Irene produced several serious landslides and mass wasting events in the Deerfield River watershed in the northwestern part of the state. In response, MGS prepared a statewide slope stability index map using a protocol similar to the one used by the North Carolina Geological Survey. This is the first statewide coverage of potential landslide hazards that incorporates detailed data sets of the topography, soils and surficial geology. The intent of these maps is to provide the public, local government and local and state emergency management agencies with a map showing the location of areas where slope movements have occurred or may possibly occur in the future under the right conditions of prolonged high antecedent moisture followed by high intensity rainfall. It is also anticipated that MassDOT and municipalities will find this information useful in planning culvert and drainage improvements in the future. These maps are a first-order approximation of potential landslide hazards across the state. They are provided only as a guide to areas that might be prone to slope instability and help identify areas where additional, site specific investigation may be warranted, particularly if they are located near major roadways, utilities or other critical facilities.

A second HMGP proposal has been recommended for funding but we are waiting for FEMA to obligate the funding. This second project will acquire shear wave velocity profile data at several representative sites across the state. This information will be used to classify the surficial materials according to the NEHRP soil categories and to improve loss estimates from various earthquake scenarios using HAZUS-MH. We are also working with a new extension faculty member to acquire the necessary seismic equipment and begin building a shear wave velocity database at critical facilities across the state.

Beginning this year, we began discussions with MassDOT to develop a protocol and decision support tool for assessing, prioritizing, maintaining, and upgrading road-stream crossings for the state. The project is unique in that the protocol will examine road-stream crossings for vulnerability not only from a hydraulic standpoint, but also from an ecological services viewpoint and geomorphic perspective. In addition, the vulnerability study incorporates climate change in the protocol. Negotiations on a scope and budget have been underway for most of the year. During this year we also submitted a proposal to FEMA under the HMGP 5% initiative to develop a fluvial geomorphological assessment protocol and database for Massachusetts similar to the ones that already exist in Vermont and New Hampshire. With rising concerns about fish passage, critical wildlife linkages, stream crossing design standards, stream restoration and climate change, there is interest in applying fluvial geomorphological principles as a tool for developing better river corridor management plans for communities. We are waiting for a funding decision from FEMA.

**DATA PRESERVATION**

MGS received a grant from the NGGDPP to scan the University of Massachusetts Department of Geosciences Contribution Series. There are 73 volumes in this series dating from 1969 to 2000. Many are out of print and about half were damaged by water during a storm that flooded the basement.
The Michigan Geological Survey (MGS) has been functioning in its new structure at Western Michigan University, Geosciences Department for just over three years. The functions of the Survey include investigation of the geological resources of the state and collection and archival of samples, cores, cuttings, and records of geological investigations in the state. The MGS function is to serve the people of the State and the governmental entities, the Client.

The MGS is continuing to operate primarily on soft money, utilizing the expertise of the faculty members within the Geosciences Department. The Survey wants to be recognized as the “Go To” resource for geologic information in the State. To meet this requirement, the Survey has established a more formalized structure of nine Resource Centers, MGRRE-Sample and Data Repository, Surface Mapping, Hydrogeology/Environmental, Energy, Economic Minerals, Geologic Hazards, GIS/Data Management, Outreach and Remote Sensing to provide the scientific information to the public and the state legislative body. To initially meet these goals, the MGS is utilizing the support of the faculty members and outside resources until funding can provide hiring of permanent staff. Recent announcements were made in Michigan on the significance of maintaining core and data in a recoverable condition.

CURRENT ACTIVITIES

The Director, John A. Yellich, has had over 90 occasions to continue the road program to introduce the “Re-invented” survey to the client, and to meet the critical stakeholders in the State during the past year. This includes meetings with the Directors in the Governor’s office and with local and regional economic development managers, business associations and a presentation to a State Senate committee to identify the geological issues currently facing the State of Michigan in all aspects of agriculture, industry and rural growth, which includes water, resource development and data management and the need for funding for the Survey. This has included formal presentations and formal and informal meetings and discussions in a number of areas of the State to develop a plan to maximize the “Re-invented” MGS’s ability to support the State as the “go to” for geological science information going forward in the changing economy. As a result of these meetings and discussions, the Directors of the Michigan Departments of: Environmental Quality (MDEQ), Natural Resources (MDNR), Office of Great Lakes (MOGL) and Agriculture and Rural Development (MDARD) established a funding partnership with MGS to support the USGS Federal mapping program. This funding partnership with the Governor’s Quality of Life Council for mapping, is the first State funding for mapping in over 30 years, which will support the USGS matching funds programs.

SAMPLE AND DATA REPOSITORY

The Michigan Geological Repository for Research and Education (MGRRE), which has functioned for over 30 years under the direction of Dr. William Harrison III, continues to be the strength of the MGS. Many requests for data review have occurred over the last 30 years at MGRRE and specifically requests for review of geologic core and data were incorporated into a collaborative carbon sequestration program, the Midwest Regional Carbon Sequestration Partnership (MRCSP) with Battelle National Labs and the Department of Energy (DOE). This technical review and field validation progressed significantly in developing Enhanced Oil Recovery (EOR) with the capture and injection of CO₂. The EOR program is one of the economic benefits of carbon capture and injection and this has resulted in the secondary recovery of more than seven (7) million barrels of entrained oil, providing millions of dollars in additional revenue for the Michigan economy. To entice additional industry efforts in this CO₂ capture and injection, Michigan modified and reduced the oil severance tax to stimulate support for expending the additional costs for this type of EOR program and that legislation was signed at MGRRE on April 1, 2014, in recognition of this data support. MGRRE continues to receive funding for core and data storage from industry donations. MGS and MGRRE (Dr. David Barnes and Dr. William Harrison) also received a four (4) year extension in DOE grant funds to continue our support to the MRCSP sequestration studies being done in Michigan.

MGRRE received a grant from the National Geological and Geophysical Data Preservation Program (NGGDPP). This year the project archived 230 oil and gas wells from 5,000 core boxes representing 15,000 feet of core and shallow bedrock data storage from 125 shallow bedrock wells and boreholes from about 770 core boxes representing 2,310 feet of core. Also included in the data preservation are approximately 6,000 oil well scout tickets that were handwritten and they were scanned and digitized.

The U.S. House of Representatives held hearings on September 17, 2014 on bill H.R. 5066 and Association of American State Geologists (AASG) representatives made presentations in support of that legislation for continued funding of NGGDPP, the data and sample preservation act. MGS submitted formal written testimony on that date in support of H.R. 5066 to continue funding for NGGDPP. The MGS testimony documented hundreds of millions of dollars in associated oil, gas and mineral revenues and associated taxes to Michigan, as a result of the MGRRE facility, also documenting the successful student theses and industry research studies and programs over the last 30 years.
MGRRE is also supporting the State Geothermal Data project, organized by the AASG with funding from the Department of Energy, which brings data from all 50 States into the National Geothermal Data System (NGDS). MGS digitized at-risk, legacy geothermal-relevant data and submitted same to the U.S. Geosciences Information Network (USGIN) data base.

OIL AND GAS
The MGS through the Resource Center at MGRRE continues to be associated with the Petroleum Technology Transfer Council (PTTC) which conducts day and multi-day workshops on oil and gas production technologies in Michigan. The Conferences in 2014 had over 200 participants at multi-session lecture conferences and technical sessions held in the State. These workshops focus on relevant topics in the petroleum industry.

GEOLOGIC MAPPING
MGS participates in both the USGS STATEMAP and Great Lakes Geologic Mapping Coalition projects under the direction of Dr. Alan Kehew. MGS did participate in presentations in February to all the Michigan delegates in Washington, D.C. requesting their continued support for funding the Great Lakes Geologic Mapping Coalition, which was successful. Emphasis in the two USGS mapping programs is now concentrated in areas of mineral resources in the Upper Peninsula and water resources and the need for accurate geologic data and aquifer characteristics in the Lower Peninsula (LP). The LP studies are being done with a refined 3D approach which includes a combination of surface geologic mapping, a limited rotosonic and geoprobe drilling program, downhole geophysical logs and incorporating the validated geologic logs from water well drillers. All these components result in a more accurate geologic depiction of the stratigraphic section and increases the quality of the data set in assessing the water bearing strata and resource availability for high production users, primarily the agricultural community. An expanded mapping program is being proposed to the State in sensitive high water use areas.

GROUNDWATER RESOURCES & ENVIRONMENTAL QUALITY AND ENERGY
The MGS has been asked to sit on the Governors’ select water advisory group, Water Use Advisory Council, which is supporting the adoption of the Great Lakes compact requiring permitting of large capacity water withdrawal wells and quantifying their impact on stream flows. Local requests are being made to MGS for information on the quality of the groundwater in certain areas of the State, but many of the requests do not have funding associated with any proposed study at this time.

ECONOMIC MINERALS
The Western Michigan University (WMU) hard rock economic mineral geologist/petrologist, Dr. Joyashish Thakurta, has focused on the rock suites of the Upper Peninsula of Michigan. His efforts will be integrated into the MGS’s role as a mapping and sample collector and analyzer of specific geologic data in little known exploration areas. He has written proposals to conduct studies with mining companies which will utilize students to sample and analyze the data for their respective thesis, the educational component of the MGS/University synergy. His contacts have also stimulated the potential for conducting an aerial geophysical survey of the Upper Peninsula to benefit the assessment of hidden mineral targets in the hardrock terrain which would enhance the state and private leasing potential for any buried mineralization targets.

GIS DATA MANAGEMENT AND MGS STORE
Sita Karki is inputting many new and historic maps and documents to meet Arc-GIS standards to the MGS data management systems. The new functioning role of the MGS has been initiated and it includes preparing documents and maps for distribution and sale through the MGS website. The MGS believes that there are many other older Michigan publications and paper resources that can be input to the document archives and made available to the scientific community and general public.

OUTREACH AND K-12
The K-12 program at MGS-MGRRE has had increasing interest by the Michigan education community under the direction of Dr. Peter Voice. This emphasis, is the importance of earth science education of our middle and high school students. Many teachers are now turning to the educational resource at the MGS-MGRRE facility. The number of contacts being made with students or general public at presentations or sessions, has increased in the last year. The Coordinator and staff have made over 16,000 contacts within this budget year and current expectations are that we will exceed last year’s contact numbers in the next year. Teachers are seeing the benefits of this program and the MGS hopes to incorporate this into the State K-12 program going forward.

REMOTE SENSING
MGS and the Remote Sensing laboratory under the direction of Dr. Mohamed Sultan is preparing proposals to support satellite imaging and airborne geophysical surveys for mapping water resources and geology.
The Minnesota Geological Survey is a department in the N.H. Winchell School of Earth Sciences, College of Science and Engineering, University of Minnesota, charged by its enabling act of 1872 to investigate the geology of Minnesota and provide geological information to the legislature and the public. The Director of the Geological Survey is, by tradition, a professor in the Department of Geology and Geophysics.

The Minnesota Geological Survey (MGS) carries out its mission through geological mapping and related studies that either contribute to the mapping effort or derive from it. Sediments deposited by Quaternary glacial processes cover the rock almost everywhere in the State. Because the Quaternary sediments and rock that they cover are both of economic and environmental significance to society, geologic mapping in Minnesota most often entails the production of two maps for any given area. In some places knowledge of the bedrock geology is the greater need; in others, knowledge of the Quaternary deposits is more critical; and in much of the State knowledge of both is required. Most of our projects in Minnesota reflect this duality of need for geological information.

**FUNDING**

A total of $3,051,197 was appropriated to the Survey, or contracted for, in the period July 1, 2012 through June 30, 2013. Of that sum:

- $1,229,025 was an appropriated line item in the University budget to support general operations. This is the MGS base budget.
- $1,654,109 was obtained for support of the County Geologic Atlas Program. The CGA program supports geologic mapping and complementary studies of geologic conditions of use to planners and resource managers at the state, county, and local level. Sources:
  - $98,361 in Clean Water Funds (special state sales tax)
  - $974,741 from the Environment and Natural Resources Trust Fund as recommended by the Legislative and Citizens Commission on Minnesota Resources (LCCMR, lottery proceeds)
  - $520,446 by contract with the Minnesota Department of Natural Resources (MnDNR), pursuant to the 1989 Ground Water Act
  - $60,561 from the STATEMAP program of USGS
- $51,411 supported geologic mapping under the STATEMAP component of the National Cooperative Geologic Mapping Program (exclusive of County Geologic Atlas work).
- $16,393 was provided by the University of Minnesota at the Twin Cities campus, and at Duluth, to support MGS staff teaching in the Department of Geology and Geophysics, and at the Precambrian Research Center
- $14,941 was provided by the USGS for the data preservation program.
- $85,318 was obtained by contract with the Minnesota Department of Health to support data entry to the County Well Index database

**ENGINEERING AND ENVIRONMENTAL GEOLOGY**

A major purpose of the CGA program is to provide the geological data that are necessary for enlightened environmental management. Such data includes maps and text materials that depict countywide geologic and hydrogeologic conditions, and databases of site-specific hydrologic and geologic information. The program also provides the training needed for effective use of these data. The atlas plates, chiefly in color at a scale of 1:100,000 are intended to assist planners, resource managers, teachers, and the general public who are not themselves geologists. The maps are published in conventional printed form, as pdfs, and as geographic information system projects and files. Computerized databases used to prepare the maps are web accessible and are updated as more information becomes available. Work was completed for the Sherburne, Morrison, Houston, Winona, Clay and Wright atlases. Compilation, analysis and map drafting is underway for the Washington, Kanabec, Meeker, Brown, Redwood, Hubbard, Wadena, and Becker atlases. Atlases have been initiated in Cass, Isanti, Hennepin, Dodge, Lake, and St. Louis counties.

Geologic mapping supported through the STATEMAP component of the National Cooperative Geologic Mapping Act has focused on areas in which environmental, engineering, and mineral resource issues are the major concerns. Bedrock geologic maps were completed for Meeker and Kanabec counties.

**QUATERNARY GEOLOGY**

Quaternary geologic maps are fundamental components of the CGA and STATEMAP projects described above. Geologic maps in these programs that are titled as “surficial” focus on Quaternary glacial deposits. MGS also employs GIS techniques to produce digital surfaces defining till boundaries and aquifers. This type of work was completed for Meeker, Sherburne, Morrison, Clay, and Wright counties.

**HYDROGEOLOGY**

Much hydrogeologic work is conducted within the framework of the CGA projects. The responsibilities for hydrogeology in the CGA program area are shared between MGS (basic data) and the MnDNR Division of Waters (sensitivity assessment; water chemistry and age, regulatory issues). Other MGS projects have substantial hydrogeologic components as well. An example is an instrumented borehole that is being used to discern the hydrologic properties of the St. Lawrence Formation.
MGS staff compiled the geochemistry of ground water and analyzed it to understand ground water flow paths in the Rochester metropolitan area.

INFORMATION SYSTEMS
MGS continues to refine and extend its capabilities in geographic information systems (GIS) and related technologies, and in the use of the Internet for disseminating data and distributing publications. Virtually all new publications are digital products, with some products also printed for non-digital users.

The County Well Index (CWI), a database of water-well records and geologic interpretations of them, now contains more than 493,000 records. The CWI database is widely used by state agencies, local government, contractors and consultants. Work began this year to rebuild the software, clean the data, and create new user interfaces for this heavily-used database.

MGS maintains a website to provide general information about our operation, updates on our activities, and direct access to many of our products.

MGS has developed a new database called Quaternary Data Index that contains information related to unconsolidated deposits, usually at depths of less than 50 feet. The database

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During Fiscal Year 2014 the Mississippi Office of Geology continued research into the surface and subsurface geology, paleontology, and mineral resources of Mississippi; regulatory responsibilities for surface mining and reclamation also continued. The Office of Geology is a component of the Mississippi Department of Environmental Quality (MDEQ), and our staff interacts extensively with personnel of the water management and pollution control offices. The State Geologist is a member of the Environmental Quality Permit Board.

SURFACE MINING AND RECLAMATION OF SURFACE-MINED LANDS
MDEQ continued to regulate all non-coal surface mines in the state as provided for in the Mississippi Surface Mining and Reclamation Act of 1977. This includes issuing surface mining permits and notices of exempt operations, inspecting permitted areas and inspecting complaints, overseeing the reclamation done by operators, and enforcing the law as per the promulgated Rules and Regulations and Commission orders. Coal and lignite mines are regulated under the Mississippi Surface Coal Mining and Reclamation Law of 1979, with oversight of the program by the federal Office of Surface Mining. The coal and non-coal regulations were renumbered recently to meet the style mandated by the Administrative Procedures Act.

In FY2014, the Mining and Reclamation Division performed 862 inspections (of which 60 were bond release inspections), recommended to the Permit Board the issuance of 17 initial and 9 amended permits, and received 74 Notices of Exempt Operations (operations less than four acres in size). A total of 1,802 exempts are on file, covering approximately 7,208 acres, and 1,028 acres were completely reclaimed as a result of the division’s efforts to oversee reclamation. The state currently has 718 permits covering 34,625 acres. The Mining and Reclamation Division continued to update the mining database. This database provides valuable mining information in a GIS format so that mining sites can be located and viewed by anyone using our online Mining Viewer.

The Mining and Reclamation Division continued to provide the required Mine Safety and Health Administration (MSHA) training for mining operations in the state. MSHA regulations require an 8-hour refresher training course be taught to all mine workers. In FY2014, division staff provided training to 80 miners and 79 contractors working in the mining industry.

The Coal Mining Division was established during FY2007 to focus on the complexities of coal mine regulation. Mississippi has an industry-estimated 5 billion tons of surface mineable lignite, a low-grade coal ranked just below sub-bituminous coal. The Mississippi Lignite Mining Company is mining lignite at the Red Hills Mine in Choctaw County to supply fuel for an adjacent 440 MW mine-mouth power plant. The mine produces over 3.5 million tons of lignite per year and has permitted 6,090 acres. This permit was initially issued in 1998, and was renewed in February 2013 for its fourth five-year term. The planned life of the permit is 30 years.

The Liberty Fuels, LLC mine permit in southwestern Kemper County was issued in December 2011. The initial permit is for 2,299 acres. The Liberty Mine will produce an average of 2.2 million tons of lignite per year for the initial five-year term, and 4.5 million tons per year for the planned forty-year life of mine. The life of mine area is planned to be approximately 440 MW mine-mouth power plant. The mine produces over 3.5 million tons of lignite per year and has permitted 6,090 acres. This permit was initially issued in 1998, and was renewed in February 2013 for its fourth five-year term. The planned life of the permit is 30 years.

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18,200 acres, in Kemper and Lauderdale counties. The adjacent IGCC power plant under construction is designed to produce 550 MW of electricity and be fueled by gas produced on-site from the lignite; construction is nearing completion.

Staff inspections of both mines are conducted at least monthly. One or more joint inspections of each mine are conducted annually with the federal Office of Surface Mining (OSM). Three permit revisions were finalized during FY2014. One permit revision was submitted during FY2014 and will be finalized during FY2015. It is anticipated at least three permit revisions will be submitted during FY2015. One bond release was processed during the year and will be approved during FY2015. One permit renewal is anticipated in FY2015, which should take approximately one year to review. One revision of the Regulations Governing Surface Coal Mining in Mississippi was completed in FY2014.

Work under Mississippi’s Abandoned Mine Land Program to identify and locate abandoned historic coal mines has identified four sites, two in Choctaw County and one each in Winston and Lauderdale counties. All of these sites are believed to have been active sometime in the period from the mid-late 1800s to the late 1920s. The landowners of the two sites in Choctaw County do not wish to have reclamation work done on the sites. The landowners of the Lauderdale and Winston counties sites do want reclamation work done. These two sites have been determined to be a physical threat to public safety and well-being, but not to have any acid mine drainage or to be an environmental hazard. Design of the appropriate reclamation work at each site was completed in FY2014.

**GEOLOGICAL DATA COLLECTION ACTIVITIES**

The department’s geologic mapping program for FY2014 was funded in part by a federal STATEMAP 2013 grant of $78,967 and an NCRDS grant of $15,000. Deliverables for the STATEMAP grant include Meridian South, Vinville, and Whynot 7.5-minute geologic quadrangle maps in Lauderdale County in east-central Mississippi and the Star, Harrisville, and Mendenhall East 7.5-minute quadrangles in Rankin and Simpson counties in south-central Mississippi. These maps were published in color at a scale of 1:24,000 as Open-File Reports OF 264-269. The 2013 STATEMAP deliverables were due at the end of July 2014. Geologic units mapped in east-central Mississippi in FY2013 and 2014 included the Tuscaloosa, Hatchetgbee, Tallahatta, Winona, Zilpha, and Koscusko formations of Eocene age and Holocene alluvium. Geologic units mapped in south-central Mississippi amounted to 610 feet. These cuttings and samples were pre-drilled in Jackson County. Total footage drilled and sampled amounted to 610 feet. These cuttings and samples were preserved and archived in the Office’s core and sample library.

Geologic mapping in FY2015 will be funded by the STATEMAP 2014 grant, which was awarded funding of $75,597. Additional assistance for mapping will come from a federal NCRDS grant of $15,000. Mapping work for FY2014 includes the Stonewall, Sable, and Snell 7.5-minute geologic quadrangle maps in Lauderdale and Clarke counties in east-central Mississippi and the Easen Hill, Vancleave, and Gautier North 7.5-minute geologic quadrangles in George and Jackson counties in southeastern Mississippi.

Two test holes were drilled to support geologic mapping: the Old River Road #1 in Jackson County to a depth of 310 feet and the Mike Van #1 in Jackson County to 300 feet. Twenty-six papers were published, including 8 articles in Environmental News, 6 articles in the Mississippi Geological Society Bulletin, one article in Marine Micropaleontology, one article in the Gilcrease Journal, 3 abstracts in the Journal of the Mississippi Academy of Sciences, Just Geology 2012–2013, and 6 geologic quadrangle maps as Open-File Reports OF 264-269.

Proposed work for the STATEMAP grant in FY2015 includes six geologic quadrangle maps. These are the Center Hill, Meridian North, and Toomsuba quadrangles in Lauderdale and Kemper counties in east-central Mississippi and the Beatrice, White Plains, and Biloxi quadrangles in Harrison, Stone, and Jackson counties in southeastern Mississippi.

Many of the Office of Geology’s publications have been scanned and made available for free download on the agency’s web site. This makes out of print publications available again and digital publications more accessible to customers. The geologic quadrangle maps are available for viewing or download as PDF files.

The Environmental Geology Division gathers, studies, and archives subsurface geological and geophysical data for ongoing projects and other studies within MDEQ. Focused research is being done with regard to groundwater and other environmental issues. The division also provides support to other state agencies and academia. The Environmental Geology Division’s geologist answers requests for information on groundwater availability, depth of wells, and potential yield of wells. In some cases, quality of groundwater is critical and this information is often available through data searches. These requests come from water well contractors, engineering firms, consultants, and private individuals.

MDEQ staff continue to be involved in the eight CUSEC states’ work disaster planning regarding the New Madrid Earthquake Zone (NMEZ). Northwestern Mississippi is at risk of significant damage to roads, bridges, utility systems, power grids, and other infrastructure along this active fault zone. Geologists from the Office of Geology are in contact with and involved in meetings regarding future projects and studies over the next several years.

Drilling and geological sampling activities were performed for the Surface Geology Division's STATEMAP program. During FY2014 the division’s drill crew drilled a total of two test holes in support of the STATEMAP grant. Both of these holes were drilled in Jackson County. Total footage drilled and sampled amounted to 610 feet. These cuttings and samples were preserved and archived in the Office’s core and sample library.

Environmental Geology’s geologist and technicians wireline logged a total of 10 test holes in counties throughout the state. Total footage logged was 3,599 feet. Eight water well contractors accounted for all wireline logging operations. Irrigation Equipment (Indianola, Mississippi) drilled the shallowest test hole in Marshall County. Total depth of this hole was 150 ft and the well was completed as a high-yield irrigation well. The deepest test hole wireline logged was secured in a 894 foot hole drilled by Donald Smith Company, Inc., (Shannon, Mississippi) for the Carnathan Brothers in Chickasaw County. The majority of the wells and test holes wireline logged during FY2014 were utility systems and industrial applications. Two wells were for private individuals.

The Environmental Geology Division’s technicians pulled, shipped and re-filed samples and cores for 16 scientists in other state agencies and oil and gas explorationists. A total of 219 boxes of cores and samples were examined during FY2014. Staff re-boxed 411 boxes of cores amounting to 822 feet.
The Geospatial Resources Division focused its emphasis on remote sensing (RS) and geographic information systems (GIS) activities. The division manages the Mississippi Flood Map Modernization Initiative (MFMMI). This program develops and updates digital flood insurance rate maps (DFIRMs) for the 82 counties under funding by the Federal Emergency Management Agency (FEMA). These resulting DFIRMs and supporting digital data are available on the Web.

In early 2014, the division completed collecting statewide subsurface geothermal information. With funding provided by the U.S. Department of Energy, the division collected approximately 10,000 bottom hole temperatures from oil and gas wells drilled throughout the state. This data was organized by the Association of American State Geologists (AASG). This project brings data from all 50 states into the National Geothermal Data System (NGDS).

The division is involved with the Mississippi Coordinating Council for Remote Sensing and Geographic Information Systems. The Council exists to set policies and standards that will promote the sharing of information, as well as facilitate the cost-sharing potential. The Council is also charged with oversight of the development of the Mississippi Digital Earth Model (MDEM). The Office of Geology is responsible for MDEM’s development, and the Geospatial Resources Division handles the assignment. MDEM consists of developing digital geographic information that will serve as the state base map. MDEM consists of eight layers of digital information that will be available on the Web: (1) geodetic control, (2) elevation and bathymetry, (3) orthoimagery, (4) hydrography, (5) transportation, (6) government boundaries, (7) cadastral, and (8) the Gazetteer. The division is responsible for the management and monitoring of MDEM data development contracts and the QA of the MDEM mapping products that result from this work. Products from this work may be used by state and local governments, engineering firms, and construction companies involved in planning, development, construction or regulatory work throughout the state.

In FY2014 the Geospatial Resources Division dealt with the FEMA flood mapping, the GIS Council, MDEM, other GIS data development, and completed the collection of oil and gas well bottom hole temperature data.

Working with FEMA and MEMA, the division continued work on completing the updating of flood map (DFIRM) projects. In 2010, FEMA began its new Risk MAP (Risk Assessment, Mapping and Planning) program. The program has shifted to HUC 8 subbasin flood studies and added flood risk assessment and flood hazard mitigation and planning activities and products. As of mid-2014, the division is working on nine HUC 8 Risk MAP projects and one LAMP (Levee Analysis and Mapping Procedure) project on the Tennessee-Tombigbee Waterway in northeast Mississippi. This project is one of 25 Pilot LAMP projects for mapping deaccredited levee systems chosen by FEMA from across the nation.

In FY2014, the division continued to work with the GIS Council and its activities. In mid-2013 Council leadership moved from MDEQ to the Mississippi Emergency Management Agency (MEMA). The division continued work with the Mississippi Department of Information Technology Services (ITS), supporting the updating and development of the Mississippi GIS Clearinghouse / Portal Project. The Portal houses and distributes all digital MDEM data for the state. The division will continue this work activity into the foreseeable future.

During 2014, the division continued monitoring and managing contractors completing work on MDEM data sets. These data included road centerlines, hydrography, and elevation/topography and Lidar data in different areas of the state. All data developed are of MDEM quality and will be made available for distribution through the Mississippi Geospatial Clearinghouse web site at: http://www.gis.ms.gov/Portal. During FY2015, the division will continue working on projects that include development of MDEM data, including attributed road centerlines and large-scale hydrography for several HUC 8 river subbasins in coastal Mississippi, and Lidar development covering the coastal area of the state.

The division maintains three web sites. For an information-rich site for oil and gas related information: http://www.library.geology.deq.state.ms.us. Another has a wealth of coastal data as a result of our twelve years of active research: http://www.geology.deq.state.ms.us/coastal. The division continues to maintain a web site for the Mississippi Flood Map Modernization Initiative (MFMMI): http://www.geology.deq.ms.gov/floodmaps. By visiting this site the public and local government officials are able to learn the current status of their county’s DFIRM mapping project. Also, when a county’s new preliminary flood maps are available, the public and local government officials will be able to download and review individual DFIRM map panels.
The Missouri Geological Survey (MGS) continued to advance initiatives to increase core science through rigorous strategic planning and realignment measures at the natural resources department level, and at the survey. The goals included better coordination and collaboration on critical natural resource issues; providing better service; and balancing financial, scientific and strategic coordination. These forward thinking efforts to better position the state for safe and timely resource development and economic viability, and to plan for natural hazards, are being undertaken through internal realignment, as well as statutory changes at the state capitol per recommendations from Governor Nixon’s office.

Primary survey responsibilities centered on geologic assessments of mineral, energy and water resources. Oversight of oil and gas production and water well construction continue. The state currently hosts 470 active industrial mineral mines; there was an increase in oil and gas production of 26% over the previous year; and staff oversaw construction of over 8,400 wells. MGS staff members have also been called upon to provide geologic support to many Missouri citizens impacted by recent geologic collapse and landslide incidents. The survey is also focusing efforts to better understand recharge of the state’s large magnitude springs located in the southeast. MGS continues to reside in the Buehler Building in the city of Rolla. The McCracken Core Library and Research Facility is located off-site within a few miles. That facility accepted 15,886 additional feet of core and cuttings in 2014. Survey staffing levels vary with fluctuations in available appropriated funding, contractual projects, federal grants, agency MOUs and other external fund sources. The survey was again able to increase its actual expenditure by a small amount. The staffing number also increased slightly to 61 full time employees.

**ADMINISTRATION PROGRAM**

The Missouri Geological Survey’s administration program provided operational support to the survey. Administration staff responsibilities include operations management, budgeting, personnel management, building maintenance and improvements, custodial services, communications and the distribution of maps and publications. Survey director Joe Gillman fulfilled the duties of State Geologist, overseeing all activities of the survey and representing the survey on several councils, boards and commissions including the State Oil and Gas Council, the Geologist Registration Board, the Well Installation Board, the and the Land Reclamation Commission. The State Geologist represents the state through the Central United States Earthquake Consortium (CUSEC) and is currently serving as Chair of CUSEC State Geologists, a subgroup of the consortium. Survey deputy director Jerry Prewett fulfilled the duties of Assistant State Geologist and was responsible for oversight of program activities, legislative actions, information technology governance, and was involved in many other state-wide initiatives.

**GEOLOGICAL SURVEY PROGRAM**

The Geological Survey Program is represented by three overarching disciplines:

1) The Geologic Resources Section supports traditional geologic activities, including geologic mapping through the National Cooperative Geologic Mapping Program, mineral and energy resource assessments, and data collection management and preservation. The section conducted geologic mapping activities in central Missouri to support infrastructure and transportation needs among many others. Other information collected and managed involved industrial and metallic minerals, coal, geothermal, hazards, mining, carbon sequestration, and bedrock core and cuttings stored in the McCracken Core Library and Research Center. Staff supported activities of the State Oil and Gas Council, Industrial Minerals Advisory Council, and the Geologic Mapping Advisory Committee.

2) The Environmental Geology Section provides geologic and hydrologic support for solid and liquid waste disposal, and remediation of hazardous waste sites where aquifers have been impacted. The section evaluated the geologic characteristics of 186 proposed animal and domestic wastewater treatment systems and 25 proposed solid waste disposal sites for potential groundwater impacts. The section also investigated petroleum contaminated sites to locate the source of the contamination where aquifers have been degraded. The section evaluated the geologic aspects of 301 sites where hazardous wastes are present or suspected, including Superfund, RCRA, Federal Facility and Voluntary Cleanup Program sites. Finally, 570 non-earthquake geologic hazards assessments involving karst features or mine collapse were conducted.

3) The Wellhead Protection Section oversees construction and plugging of wells associated with water use, monitoring, minerals, and ground source heat pumps through regulatory standards. The section provides technical assistance on well construction, aquifers and hydrology to thousands of businesses, farmers, and citizens on an annual basis. Fees charged for well installation support this section.
The Montana Bureau of Mines and Geology (MBMG), founded in 1919, is a non-regulatory, research agency and State geologic survey within the Montana University System and a department of Montana Tech. MBMG provides extensive advisory, technical, and informational services to the public and other agencies to inform responsible development and protection of Montana’s mineral, energy, and water resources. Staff scientists conduct independent studies and typically have cooperative investigations with more than 70 different local, state, federal, and private organizations. MBMG also responds to thousands of informal queries for information and assistance.

MBMG’s primary office is on the Montana Tech campus in Butte; a branch office is located in Billings. The staff is comprised of about 50 scientists and 15 technicians and support personnel; about 30 students work part time. Staff numbers and budget are generally stable, but have increased with the initiation of the Ground Water Investigations Program. John Metesh became director on October 1, 2012.

MBMG conducts research into all aspects of the geology of Montana, but groundwater dominates our work. Information for many of these projects can be found at http://www.mbmg.mtech.edu/grw/grw-main.asp. Major groundwater efforts include:

GROUND WATER ASSESSMENT PROGRAM (GWAP)

Montana’s 1991 Ground Water Assessment Act provided a three-part program (groundwater characterization, long-term water-level monitoring, and a groundwater database) designed to systematically assess Montana’s groundwater resources on a state-wide level. Characterization studies are conducted on a drainage-basin scale and result in maps and atlases summarizing the hydrogeology of the basin. The core of GWAP’s monitoring program is a statewide network of about 950 wells where water levels are collected at least quarterly. About 75 wells are sampled for water-quality analysis annually. The Ground Water Information Center (GWIC) database contains all GWAP data, including that obtained from driller’s logs, published reports, field measurements, laboratory analyses, and other sources for about 250,000 sites; groundwater data collected from other MBMG projects; and more recently groundwater data collected by some private entities. Water-well drillers must now submit their well records directly to the MBMG. The GWIC database is available publicly at http://mbmggwic.mtech.edu.

Scanned images of well logs are also being added. GWIC users average about 40,000 queries per month. The Ground Water Assessment Program has completed field work in 8 areas (22 counties) and released 56 maps and reports; eight other maps and reports are in progress.

GROUND WATER INVESTIGATIONS PROGRAM (GWIP)

Recognizing that competition for water resources and the lack of detailed information on groundwater/surface water interaction has challenged informed water-resource management and development in Montana, the 61st Montana Legislature funded the Ground Water Investigations Program. This program complements GWAP by providing for more detailed and quantitative studies at the sub-basin scale. Four areas were completed in the first biennium and studies in new areas are in progress.

OTHER GROUNDWATER PROJECTS

The MBMG works in concert with State and Federal agencies, conservation districts, water-quality districts, and local communities across the entire state on many relatively short-term projects that address local issues such as water supplies, water quality, or effects to groundwater resulting from land-use changes. These projects constantly change in response to need. Longer term, the MBMG performs monitoring and local specific investigations in the Butte-Anaconda area through contracts with regulatory agencies and the Montana Department of Justice. This area has been subjected to releases from mining, milling, and other industrial sources over many decades that resulted in designation of upper Clark Fork River basin as the largest superfund site in the U.S.

Another long-term commitment is monitoring in the Controlled Ground Water Area (CGWA) along the northern and western boundaries of Yellowstone National Park that was established by compact between the National Park Service and the State of Montana to protect the geothermal resources in the Park. Estimates are that greater than 75 percent of the waters entering and leaving the Park flow through the CGWA. MBMG has completed an inventory of wells and springs, has collected baseline water-quality data for watersheds within the controlled groundwater area, and is maintaining long-term monitoring program with funding provided through the NPS.

MBMG also continues monitoring that was started in the 1970s in the Powder River coalfields. This serves a variety of purposes, from documenting the effects of coal mining on aquifers, to mine reclamation, to effects of coalbed methane production on aquifers and surface waters.

GEOLOGIC MAPPING

The first priority of MBMG’s geologic mapping program is 1:100,000-scale digital coverage of the State’s ninety-four 30’x60’ quadrangles. Including several USGS products, 77 quadrangles are now publicly available; two more are imminent. Quadrangles lacking coverage are in the western part of the State. With support from STATEMAP, selected 1:24,000-scale quadrangles are being mapped to: 1) resolve the complex structural features and immensely thick stratigraphic sequences of western Montana; leading to eventual 1:100,000-scale coverage or; 2) to provide more detailed mapping in valleys and urban areas that are experiencing high growth rates and land-use pressures. The inevitable encroachment of development on mountainsides is commonly accompanied by severe problems with water resources and slope stability. PDF versions of our digital maps are viewable and downloadable from MBMG’s website http://www.mbmg.mtech.edu/grm/grm-statemap.asp.
In addition to MBMG's mapping, the EDMAP section of the National Geologic Mapping Program is very active in Montana. These projects provide valuable detail and interpretations that greatly augment and improve our own mapping. About five projects are conducted in most years.

**EARTHQUAKE STUDIES**

Western Montana's history of large damaging earthquakes is well known. A large earthquake in 1909 located somewhere near the Montana—North Dakota—Saskatchewan border is less well-known but documents that “seismically quiet” areas are not necessarily inactive at longer time scales. MBMG's Earthquake Studies Office monitors earthquake activity in Montana and the surrounding area through a network of 42 in-state stations, plus data from several networks in bordering states. Data are exchanged with seismic research centers in surrounding states and the USGS National Earthquake Information Center, so that the public and emergency responders are rapidly provided with information about the location and severity of significant earthquakes affecting the state. Near-real-time records for each station can be viewed at [http://mbmgquake.mtech.edu/index.html](http://mbmgquake.mtech.edu/index.html).

**ENERGY RESOURCES**

According to the U.S. Department of Energy, Montana ranks first among the states in its coal-reserve-base tonnage. MBMG's coal-lands resource programs include geologic and hydrogeologic research, collection and evaluation of data concerning location, quality, and quantity of coal reserves, and dissemination of coal-related information. Historically, coal resources, mining, and their effects on aquifers were the focus of research, but in the last decade questions related to coalbed methane have renewed impetus to the coal program and associated monitoring. MBMG's NCRDS (National Coal Resources Data System) database contains data on stratigraphy, lithology, and thickness of coal resources for more than 6,800 locations throughout the state. More than 30 years of water-level and water-quality data, covering about 250 wells, are included in the hydrogeologic database, making this the oldest continuous groundwater database available in Montana. A database containing geochemical information on the overburden in some areas is also available.

In response to demand for information on “deep” coalbeds that might be suitable for in situ gasification, MBMG has used data from oil-well logs to compile maps that depict depths and thicknesses of coal beds greater than 500 feet deep in eastern Montana.

Coalbed methane (CBM) is a separate, yet integral, aspect of coal resources in the Powder River Basin. With support from BLM, USFS, and other agencies, MBMG staff have provided technical hydrogeologic support and maps showing CBM potential, wells, springs, selected geology, and other data pertinent to CBM in the Montana portion of the Powder River Basin.

**MINERAL RESOURCES AND DATA PRESERVATION**

MBMG provides technical information on mineral resources through our mapping, our archival records as well as personal communications, mineralogical determinations, petrographic analyses, and information on recent developments in industry. MBMG's mining archives contain more than 4,000 mineral property files and more than 20,000 entries in the historical claim-map and mine database. These documents are regularly used by the public for a wide variety of interests, many of which are not geologic. In addition, the Anaconda Research Collection of specimens from the Butte mines is available to qualified researchers.

**ANALYTICAL LABORATORY**

The Analytical Division provides multi-element inorganic and organic analyses of waters, rocks, soils, sediments, and biological materials for MBMG scientists and affiliated researchers, using methods that conform to U.S. Geological Survey (USGS) and EPA protocols. Most of the work is related to groundwater, and the resulting data are entered directly into the GWIC database. Besides service work, the Analytical Division participates in geochemical research. Major instruments in the lab include ICP/AES, GC/MS, GC/ECD, ICP/MS, ion chromatographs, liquid scintilometer, and hand-held XRF. Instruments for stable isotope analyses in water have been added. Analyses include δD and δ18O/16O as well as deuterium and protium. A new stable carbon isotope analyzer has just been installed this fall. Additions to the rock lab include new minerals separation and microscopy capabilities.

**GEOGRAPHIC INFORMATION SYSTEMS**

The GIS/Computer Services Division is a key component in meeting MBMG's effort to provide digital data, databases, and web-based information. They develop and maintain the computer infrastructure, capture and convert data into an electronic format, identify methods by which researchers can analyze and interpret data using GIS technology, and assist with the efficient dissemination and distribution of electronic data. Nearly all new maps are now provided either digitally or as print-on-demand products. Improvements in map delivery are in progress.

**PUBLIC INFORMATION AND SERVICES**

MBMG's Publication Division oversees release of research results as reports, bulletins, maps, or other publications. MBMG's website provides general information about the Bureau, its activities and projects, and various searchable databases on various topics including publications, groundwater data, abandoned/inactive mines, coal, and a soon-to-be launched database of historical mining files. Additionally, MBMG staff provide information through talks, personal contacts, and responses to thousands of informal requests. Through an agreement with the USGS, MBMG maintains an Earth Science Information Center for the sale of USGS publications. Increasingly, our publications are released in a digital format, with paper copies as an option. Our customers have responded; during the past biennium sales of paper copies declined while downloads of digital products soared to approach 500,000 copies.

**MINERAL MUSEUM**

Montana Tech’s Mineral Museum, administered by the MBMG, houses one of the best mineral collections in the Pacific Northwest. About 1,500 fine specimens are on display and new acquisitions are added based on their significance to the collection and to the region. Major advances in lighting and new displays have been made during the past year and are continuing. The museum sponsors a popular workshop and lecture series devoted to aspects of regional geology. In addition, schools and special interest groups may request tours and special workshops.
The Conservation and Survey Division (CSD) of the University of Nebraska-Lincoln (UN-L) is a research, service, and data-management organization that was established by state statute in 1921. It includes the state geological, groundwater and soil surveys, and it is mandated to investigate geological natural resources in the state. CSD was merged into the School of Natural Resources (SNR) in 2003, but its defined mission and identity remain. In 2013/2014, division staff consisted of 25 FTE: 13 geoscientists and 12 technical and support positions, including clerical, cartographic, IT, and field support. The portion of the School of Natural Resources (SNR) budget that is directed to the Survey Division is 2.6 million dollars.

EDUCATIONAL OUTREACH

CSD personnel, in cooperation with faculty of the Department of Earth and Atmospheric Sciences at UN-L, organized and hosted the annual meeting of the North-Central Section of the Geological Society of America in Lincoln during April 24–25, 2014. More than 400 geoscientists attended the meeting. SCD personnel made multiple presentations to various stakeholder groups over the past year and they continue to be involved in the Nebraska Water Leaders Academy. The Nebraska Maps and More store http://nebraskamaps.unl.edu continues to expand its retail offerings in Earth sciences and natural history. The SNR website http://snr.unl.edu/data/geologysoils/index-geologysoils.asp also contains a great deal of information produced by the CSD.

GEOL OGY

CSD geologists conduct basic geologic research relevant to Nebraska. Core programs of the Geological Survey include geologic mapping, stratigraphic research, mineral resource assessments, test hole drilling, and service to the public.

Test-Hole Drilling—Test hole drilling continues to be an integral part of the geological and water surveys. Projects focus on support of the geologic mapping program, water survey activities, and service to local agencies such as the Nebraska’s Natural Resources Districts. CSD maintains an extensive inventory of core and cuttings, which is accessible by request, and a test-hole database that includes lithologic and electric logs from some 5,500 test holes across the State. Efforts are underway to update this database with data from recent drilling projects. CSD acquired a $740,000 grant from the Nebraska department of Environmental Quality to drill test holes in strategic areas to update the test-hole database.

Geologic Mapping—Geologic mapping projects continued with the support of the U. S. G. S. STATEMAP cooperative geologic mapping program. Maps completed under this program can be found on the SNR website http://snr.unl.edu/data/geologysoils/digitalgeologicmaps/digitalgeologicmaps.asp. Current mapping areas lie within and adjacent to the Platte, Niobrara, and Missouri River Valleys, as well as the metropolitan fringe of eastern Nebraska. Four new 7.5 minute quadrangles were mapped in 2013–2014.

Stratigraphic Research—CSD personnel are gradually revising the stratigraphic framework of Nebraska. There are ongoing stratigraphic and sedimentologic studies of the Ogallala Group in western Nebraska, the Cretaceous Dakota Formation, and the Upper Pennsylvanian-Lower Permian cyclothem in southeast Nebraska.

Mineral Resources—CSD geologists continue to study and assist in the characterization of the Elk Creek carbonatite in southeast Nebraska, one of the largest global resources of niobium and rare-earth elements. CSD possesses thousands of feet of core, maps, and data from studies conducted on the Elk Creek carbonatite in the 1970s and 1980s. CSD geologists are also assisting producers in evaluating the potential for production of agricultural lime, cement resources, and aggregates.

Other projects—Continuing geologic research by CSD personnel also focuses on dune fields along the Loup, Platte, and Elkhorn rivers, historical change along the Platte River, the mineralogy and geochemistry of acid rock drainage sites, and landslides.

RECENT PUBLICATIONS

BY GEOLOGICAL SURVEY PERSONNEL


Puta, R. A., Hanson, P. R., Young, A. R., 2013. Late Holocene history of dune activity along the Elkhorn River in northeastern Nebraska, Great Plains Research 23 (1), 11–24. This manuscript won the Charles E. Bessey Award for the best natural sciences article in Great Plains Research in 2013.
GEOLOGIC MAPS PUBLISHED IN 2014
Hanson, P.R., Dillon, J.S., Bruhler, J., Howard, L.M., 2014. Surficial Geology of the Kearney 7.5 Minute Quadrangle, Nebraska. [Link](http://snr.unl.edu/data/geologysoils/digitalgeologic-maps/digitalgeologicmaps.asp)


Korus, J.T., Howard, L.M., Kuzila, M.S., Joeckel, R.M., 2014. Surficial Geology of the Table Rock 7.5 Minute Quadrangle, Nebraska. [Link](http://snr.unl.edu/data/geologysoils/digitalgeologic-maps/digitalgeologicmaps.asp)

Young, A.R., Howard, L.M., Hanson, P.R., Kuzila, M.S., 2014. Surficial Geology of the Crete North 7.5 Minute Quadrangle, Nebraska. [Link](http://snr.unl.edu/data/geologysoils/digitalgeologic-maps/digitalgeologicmaps.asp)

SOILS
As part of the National Cooperative Soil Survey, in cooperation with the U.S. Natural Resources Conservation Service, the CSD soils program works with the NRCS in inventorying, studying and interpreting soils. It also studies the formation and structure of soils as they relate to the landscape, geology and climate of Nebraska and integrates this research with studies in geology, groundwater, waste disposal, agriculture, civil engineering and other related disciplines. All 93 Nebraska counties have had a modern soil survey, a process that began in the mid-1950s. This map-based information is available on the Web Soil Survey.

Soil survey work continues as updating of this information is needed to meet more exacting demands for more detailed and accurate soils data. Continuing soils research by CSD personnel includes studying the, the genesis and morphology of loess soils in the Midwestern US, Rapid assessment of US soil carbon, and Phosphorous loading potential of soils in the U.S. Work has begun on developing bulletins pertaining to the interpretation of soils information for a variety of uses. The first of these will address soil water storage capacity for use in making decisions about scheduling irrigation.

WATER
CSD ground-water activities have been ongoing for more than 75 years and include aspects of research, scholarly service and teaching. Concerns about availability of water and measurements of water levels continue, with parts of Nebraska experiencing abnormally dry conditions during the early growing season. CSD personnel maintain a monthly recorder and real-time monitoring well networks and assist other governmental entities in establishing or expanding their monitoring networks. CSD continues to analyze water level data collected in cooperation with the Nebraska Natural Resources Districts and state and federal agencies and produce annual reports.

Regulations regarding grout requirements for water wells were adopted by Nebraska state regulators. These new requirements were designed on the basis of studies conducted in by CSD hydrogeologist Susan Lackey, in cooperation with other State and local agencies.

In 2013 and 2014, CSD drilled nearly 20,000 feet of new test holes were drilled in cooperation with the Nebraska Department of Environmental Quality as part of an EPA-funded project to evaluate geology and install new water quality monitoring wells. A test hole in central Nebraska was drilled to a depth of 1700+ feet, the third deepest test hole ever drilled under the supervision of CSD geologists.

CSD continues its cooperation in the Eastern Nebraska Water Resources Assessment (ENWRA). Planning is currently underway for a major effort to conduct a large reconnaissance survey of eastern Nebraska using air-based time-domain electromagnetics. CSD will conduct geologic interpretation and test-hole drilling in support of this project.

RECENT WATER SURVEY PUBLICATIONS


The Nevada Bureau of Mines and Geology (NBMG) is a research and public service unit of the University of Nevada and is the state geological survey. Established by the Nevada Legislature as a department within the public service division of the University and Community College System of Nevada, NBMG is part of the Mackay School of Earth Sciences and Engineering within the College of Science and is one of the statewide programs at the University of Nevada, Reno. NBMG’s mission, to provide the State’s needs for geological and mineral-resource information and research, is defined in its enabling legislation. NBMG scientists conduct research and publish reports that focus on the economic development, public safety, and quality of life in urban and rural areas of Nevada. These include reports on mineral and energy resources; engineering geology; earthquakes, floods, land subsidence, and other hazards; environmental geology; groundwater; and geologic mapping in Nevada. NBMG has no regulatory function but assists other state agencies in matters concerning geology. NBMG also has cooperative research and information programs with numerous local, state, and federal agencies. Geological highlights in Nevada in recent years have involved mineral-resource, geothermal, water-resource, natural hazards, and environmental issues. Current focus areas for NBMG include: 1) detailed geologic mapping and assessments of geologic hazards and natural resources in Clark County in southern Nevada, particularly the Las Vegas metropolitan area; 2) detailed geologic mapping and assessments of natural resources (mineral, oil-gas, and geothermal) in northeastern Nevada; and 3) detailed geological mapping and assessments of geologic hazards and natural resources in the Reno-Carson City urban corridor in western Nevada.

MINERAL AND ENERGY RESOURCES, GEOCHEMISTRY, AND BASIC GEOLOGY

Current NBMG activities include detailed geologic mapping and stratigraphic studies in Nevada; research on the origin of gold and other metal deposits; geochemical investigations of mining districts; resource assessments on public lands; investigations of geothermal resources in the Great Basin region; and monitoring mineral and energy production, resources, and reserves. Major geologic resources in Nevada include mined and quarried mineral resources, geothermal power, petroleum, and water. Nevada leads the nation in the production of gold, lithium, barite, magnesite, and, in recent years, overall nonfuel mineral production. Mining in Nevada helps place the United States in the midst of its biggest gold boom in history. Nevada is also rich in geothermal energy, and NBMG research is facilitating expansion of this renewable energy resource across Nevada and surrounding regions.

ENVIRONMENTAL, ENGINEERING, AND URBAN GEOLOGY

Major projects include investigations of earthquake hazards, crustal strain, and related aspects of neotectonics; studies of land subsidence in Las Vegas Valley and near some of the mines and geothermal power plants; investigations of flood hazards on alluvial fans, rivers, and major streams; radon-hazard studies; studies of geochemical hazards from inactive and abandoned mines and naturally contaminated areas; and studies of the geochemistry of lakes at inactive open-pit mines. The NBMG’s Geodetic Laboratory has built a network of global positioning system (GPS) stations across the Great Basin and is at the forefront of global research in geodesy. Programs are underway to increase the public awareness of earthquakes in Nevada and to prepare for emergency response when a major earthquake occurs. Satellite-based interferometric synthetic aperture radar (InSAR) is also being used to evaluate geologic hazards.

GEOLOGIC INFORMATION

Activities include producing and updating databases on mining districts, active mines and prospects, abandoned and inactive mines, geologic maps, geochemical samples, and geothermal and petroleum exploration and production; building layers and metadata for statewide geographic information systems (GIS); and maintaining core and cuttings facilities, rock and mineral collections for research, aerial photographic imagery and maps, and extensive files on Nevada geology and resources. Paper records are progressively scanned and served to the public on the Web, and new geologic maps and reports are released in digital form with options for printing on demand. In collaboration with the U.S. Geological Survey (USGS), NBMG’s Information and Publication Sales Office serves as a one-stop shop for geological information in Nevada, both electronic and hard copy. NBMG’s public outreach and information program is directed at K-12 teachers and the general public. NBMG scientists frequently lead field trips and present talks, demonstrations, and slide shows for schools, universities, civic groups, and professional organizations. The NBMG home page on the Web (http://www.nbmg.unr.edu/) serves thousands of users per week and contains information on NBMG products and staff, publications available for ordering, holdings in the NBMG information office, and electronic versions of many publications. An updated index to all publicly available geologic maps in Nevada is also available on the webpage. In 2009 NBMG opened the Great Basin Science Sample and Records Library, which serves as the repository for geological samples from Nevada and houses the information and publication sales office for NBMG.

NBMG chairs the State Mapping Advisory Committee (SMAC), which advises the U.S. Geological Survey on priorities for mapping. The GIS Subcommittee of SMAC has helped to create a Virtual Clearinghouse for Nevada Geographic Information. The Geologic Mapping Subcommittee of SMAC advises NBMG on geologic mapping priorities. NBMG also chairs the Nevada Hazard Mitigation Planning Committee and participates in the Nevada Earthquake Safety Council, the State Clearinghouse, and activities of the Geological Society of Nevada, Nevada Mining Association, and local sections of the American Institute of Professional Geologists, Association of Engineering Geologists,
The New Hampshire Geological Survey (NHGS) was established by legislation in 2001 to “collect data and perform research on the land, mineral, and water resources of the state, and disseminate the findings of such research to the public through maps, reports, and other publications.” This substantially redefined the pre-existing Office of the State Geologist which was established in 1839. The NHGS is a unit within the Commissioner’s Office of the New Hampshire Department of Environmental Services.

PERSONNEL

Three of the five FTEs are fully supported by external funds as are temporary part-time positions that are assigned to specific grant-funded projects on an as needed basis. One part time, state-funded position serves as the Education and Outreach Coordinator. A number of volunteers provide ongoing critical services as part of the geologic mapping and ground water level monitoring programs.

GEOLOGIC MAPPING

Surficial geologic maps completed under the most recent STATEMAP scope of work included the Stairs Mountain, Sugar Hill, and Woodstock 7.5-minute quadrangles. This brings the total number of quadrangles mapped to 117 out of the 213 7.5-minute quadrangles that comprise New Hampshire, representing fifty percent of the state. Bedrock geologic mapping was completed for the Enfield 7.5-minute quadrangle. Efforts were also directed toward digitization of 13 existing manuscript surficial geologic maps to expand the holdings in a geodatabase format to support GIS applications.

The annual Geologic Mapping Workshop, hosted since 2001 by NHGS as a venue to present the most recent STATEMAP and FEDMAP products and other topics of interest, attracted approximately 80 geoscientists.

The FEDMAP Northern Appalachian Bedrock Mapping Project continued to focus on the Connecticut River Valley, spanning the border between New Hampshire and Vermont.

GEOLOGIC HAZARDS

The geologic hazards program in NHGS continues to evolve into its role as a key component of New Hampshire’s flood risk management strategy. Three staff members (two full- and one part-time) serve a number of roles to benefit multiple state agencies and the citizens of New Hampshire. During the past 5 years, we have performed fluvial geomorphology assessments on 400 miles of rivers in the state to identify river reaches at greatest risk of bank erosion, culvert blowouts and channel change that can occur during high flow events. With this dataset, the program is transitioning from an emphasis on data collection to projects involving the interpretation of the data to identify those sites on rivers that are most prone to flood and river channel change hazards, information increasingly requested by state agencies and town officials. In fact, we will be hiring an additional temporary part-time position to conduct such a data analysis project within the next few months. Staff continue to provide technical expertise and site-specific guidance to state agencies and communities following significant storm events. During 2014, the geologic hazards program also assumed administrative responsibility for the New Hampshire Silver Jackets, a team of 12 state and federal agencies that come together to publish papers in the peer-reviewed literature and in symposium proceedings, abstracts, and contract reports.

With the help of a donation establishing the Jay A. Carpenter Fund, in honor of the NBMG Director from 1939 to 1951, NBMG has acquired a wide map scanner and is in the process of electronically scanning all of its Information Office unpublished files, including thousands of mine maps and reports. The materials are served to the public over the Web. In addition, NBMG has scanned oil, gas, and geothermal well logs and aerial photographs.

STAFF

NBMG employs about 35 individuals, including fourteen geoscientists, five professionals in support of publication production (cartographers and GIS specialists), one information specialist, four management assistants in support of publication sales and administrative and clerical needs, ten graduate student assistants, and several undergraduate student assistants. In addition, five emeritus staff members are engaged in various professional activities. More information about products, programs, and staff is available on the Web at http://www.nbmg.unr.edu.

NEW HAMPSHIRE

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The New Hampshire Geological Survey (NHGS) is a unit within the Commissioner’s Office of the New Hampshire Department of Environmental Services.
address the response to a flood event and collaboratively work to reduce the state’s long-term flood risks. The Silver Jackets, an initiative of the U.S. Army Corps of Engineers, in New Hampshire evolved from a team that was formed by the state in the aftermath of Tropical Storm Irene to address the issues and impacts resulting from that storm. We continue to maintain a very strong relationship with the New Hampshire Division of Homeland Security and Emergency Management (HSEM). In the coming year, program staff will continue working with state and federal agency partners to expand outreach activities focused on local community officials and citizens relative to the flood risks that the state faces. An analysis of collected river condition data will also be conducted as part of the development of New Hampshire’s flood risk management strategy.

WATER RESOURCES AND GIS
NHGS continued its active stewardship of both the National Hydrography Dataset and the Watershed Boundary Dataset for New Hampshire under a formal Memorandum of Understanding with USGS. A special project to pilot methods of extracting streams from LiDAR-derived land surface elevation data and 4-band digital orthophotography was completed and a final report documenting the work was released. A complementary initiative to monitor stream permanence in headwater channels using state sensors at nine sites with varying hypsography and surficial geology in the southeastern part of the state continued though the ice-free months. NHGS has begun the final year of a data integration project funded by the US Environmental Protection Agency to improve the quality and utility of the National Hydrography Dataset for New Hampshire by expanding the hydrographic network to include connections with the stormwater and sewer infrastructure in selected areas of the Great Bay Estuary watershed. Funding has also been received for a 3-year project to develop “Web Services and Applications to Monitor Environmental Trends: Stream Temperatures and Groundwater Levels in New Hampshire.” The statewide groundwater level monitoring network has remained stable with the critical assistance of volunteers who make measurements and download data on a monthly basis.

Topobathymetric data for the entire Suncook River valley is now available, based on a survey conducted in early November 2013 by the USGS Coastal Geology Program using their EAARL-B (Experimental Advanced Airborne Research LiDAR) system, under contract by NHGS (and under nearly ideal conditions). A major channel avulsion occurred on the Suncook River during a flood in May 2006 and the system has been undergoing significant adjustments since then. Active headcutting has slowed over the past two years but still threatens to destabilize a heavily used highway bridge located a relatively short distance upstream. The LiDAR-derived DEM for the river channel and floodplain provides a high-resolution dataset as a baseline for ongoing monitoring. NHGS expects that the community of fluvial geomorphology and ecohydrology researchers will find this unique dataset to be of particular interest.

The State Geologist initiated a Capital Budget request during the fiscal year 2016-2016 biennium to acquire Quality Level 2 airborne LiDAR for the remainder of the state, and is actively working to build support within the NH Legislature.

Electronic reporting of well construction data is now being practiced by the largest water well drilling companies in the state. However, the majority of licensed water well contractors still report using paper forms. Lack of NHGS staff resources to perform manual data entry has resulted in the accumulation of a data entry backlog of approximately 1,000 hard copy reports. Some issues also remain with respect to the accuracy of self-reported well locations and development of appropriate QC procedures is pending the availability of additional resources. Funding for a summer intern to perform data entry has been requested in the NHGS budget proposed for the next biennium.

NHGS has begun a 2-year project, “Assessment of Offshore Sources of Sand and Gravel for Beach Nourishment in New Hampshire,” in partnership with the University of New Hampshire Center for Coastal and Ocean Mapping and funded by Bureau of Ocean and Energy Management. In this regard, we join with other Atlantic Coastal states in efforts to enhance coastal resiliency in anticipation of future “superstorms” like Hurricane Sandy. NHGS is in the process of using GIS to analyze changes in shoreline positions and quantify sand loss trends of New Hampshire beaches based on repeat airborne LiDAR datasets and a sequence of historical aerial photography.

EARTH SCIENCE OUTREACH AND EDUCATION
NHGS has been actively participating in the organization of the upcoming 2015 NEGSA meeting at the Mount Washington Hotel in Bretton Woods, following a highly successful meeting at the same venue in March 2013. The State Geologist and the Flood Hazards Program Manager also served on the organizing committee of the 2014 NH Water and Watershed Conference at Plymouth State University and co-chaired different theme sessions. The Education and Outreach Coordinator routinely replies to numerous requests from both the public and private sector for geologic information on a wide range of topics. Some of these requests are invitations from schools for classroom presentations. The Coordinator oversees the organization and availability of all of the NHGS publications. A complete list of NHGS Maps and publications is available at: http://des.nh.gov/organization/commissioner/pip/publications/geologic/index.htm. Hard copies of any of these publications can be ordered by contacting the NH Department of Environmental Services Public Information Center, at pip@des.nh.gov; NHDES – PIC, PO Box 95, Concord, NH 03302-0095; (603) 271-2975; or FAX (603) 271-8013 or by emailing Lee Wilder, NHGS Public Outreach Coordinator at geology@des.nh.gov
The New Jersey Geological and Water Survey (NJGWS) was founded in 1835 as a public service agency mandated to investigate the state’s geology, mineral and ground-water resources, and produce topographic maps. The new responsibilities of the Survey to regulate water resource allocations and well drilling within the NJ Department of Environmental Protection have provided a welcomed opportunity for increased work and staff. The aftermath of Superstorm Sandy has imposed additional challenges. NJGWS remains committed to providing sound science to state agencies, the general public, business and environmental communities.

New Jersey has complete digital coverage of bedrock and surficial geology at 1:100,000 scale available for download and viewing at http://www.njgeology.org. All STATEMAP quadrangles are published online as PDFs and many are downloadable as digital products. All previously published maps and reports are available free at http://www.njgeology.org/enviroed. This information is also available through a Geologic Profile launched from a new web application called NJGeoWeb at http://www.nj.gov/dep/gis/geowebsplash.htm.

Geoscience data required for water-resource evaluations are collected, compiled and made available to state offices and the public through the website. The Survey also issues water allocation and well drilling permits and is responsible for future water resource planning under the State Water Supply Plan. This includes a greater role in interstate water issues such as the impact of natural gas development on water resources and the drafting of regulations for natural gas development by the Delaware River Basin Commission. In this regard, the Survey’s work on the potential for carbon sequestration in New Jersey’s Mesozoic Basin was extended to evaluate the potential for shale gas in the Lockatong Formation. Geological sequestration targeted the underlying Stockton Formation and provided the structural and stratigraphic framework to extend evaluations for gas potential of the overlying Lockatong shale.

Monitoring of flooding and drought conditions was used to assist in addressing frequent heavy rainfall events including Hurricane Irene in 2012 and Superstorm Sandy in 2013. A suite of indicators is used to evaluate water-supply sources that include stream flow, unconfined ground-water levels, precipitation, and reservoir levels. The indicators rely on daily real-time data reported on the internet. Precipitation trends are evaluated using data from the Middle Atlantic River Forecast Center. Reservoir levels are reported on the internet by purveyors on a regular basis. Indicator status is reported at http://www.nj drought.org.

The groundwater quality network continues to sample and monitor 150 wells statewide. All wells are screened just below the water table in urban, agricultural and undeveloped land-use areas. Samples are analyzed for major ions, trace elements, nutrients, pesticides, VOCs, radioactivity and field parameters. Indicators developed from these data provide information on the status and trends of shallow-ground-water quality as a function of land use and changes. Analysis of three, 5-year cycles of data revealed a gap in trends of water quality due to land use changes during the 15 years of monitoring. A status and trends report on ground-water quality based on the three cycles is completed. Based on this analysis, the sampling cycle has been adjusted to 3 years to address gaps in data.

Geologic and hydrogeologic assistance is provided to the Department Site Remediation Program. This includes surface and borehole geophysics, ground-water geochemistry, aquifer studies, drilling and test pit excavations. In addition, the Survey performs field investigations to preserve parkland, game lands, nature areas, and farmlands in coordination with New Jersey’s Green Acres Program: www.nj.gov/dep/greenacres by investigating possible environmental problems/liabilities, ground-water protection value and unique geology. Brownfields area for redevelopment are mapped under the Brownfield and Contaminated Site Remediation Act of 1997 http://www.nj.gov/dep/njgs/geodata/dgs04-7.htm.

Along with other states, NJGWS completed data compilations for the National Geothermal Data System to support the AASG country-wide assessment of geothermal energy for the U.S. Department of Energy (USDOE). Compiling state-specific geothermal data in an integrated, distributed and searchable data system will drive renewed efforts to identify, assess and exploit geothermal energy resources across New Jersey and the country. In New Jersey these systems involve heat exchange where the ground provides for the cooling of circulation water in the summer and heating in the winter. The data compilation has help local industry in development of geothermal energy projects.

The Survey conducts geological and geophysical investigations of the inner Continental Shelf to map the State’s offshore geology and identify sand resources for beach protection. Interpreted seismic data confirmed with cores is provided to the US Army Corps of Engineers Philadelphia and New York Districts regional sand management program. A new grant from the US Dept. of the Interior, Bureau of Ocean Energy Management has boosted the analysis of the offshore sand resources. Post Superstorm Sandy, the State has moved quickly to repair 25% of the coastline along the northern/northeast part of the State. Over 14M cu yds of sand were lost from beaches in these areas. Rebuilding projects have replaced these losses and are now focused on strengthening coastal resiliency where past erosion has reduced beach width and dunes. Current exploration for additional sand resources is focused on coring features in waters extending up to about eight miles offshore along the section of the coast between Barnegat and Manasquan Inlets. Offshore communities and parks along this stretch of coastline include Island Beach State Park, Seaside Park, Seaside Heights, Lavallette, Bay Head, Mantoloking, and Point Pleasant. Over 330 line miles of high-resolution seismic data are being used to focus the coring.

A long term benefit of this program is development of a geologic framework for offshore New Jersey in the form of published maps. In press is the offshore geologic map depicting
the “Geology of the New Jersey Offshore in the Vicinity of Cape May”. This joins the “Geology of the New Jersey Offshore in the Vicinity of Barnegat Inlet and Long Beach Island” (Uptegrove, et al., GMS 12-3). Other maps depicting sand shoal areas offshore of Ocean and Monmouth Counties are under development.

**Damaging earthquakes** in New Jersey, similar to the 5.8M earthquake in Virginia in 2011 are rare, but have occurred. Structural damage caused by an earthquake depends on ground shake which in turn, depends on how soft and deep the soil is, and on the type of bedrock lying beneath it. Also important is whether the soil will lose strength, liquefy or slide downhill when shaken. Computer software (HAZUS) developed under the direction of the Federal Emergency Management Agency (FEMA) simulates ground-shaking, building damage, and estimate economic loss, for potential earthquakes. Results of these simulations are completed for one county each year and used to guide the strengthening of structures built on vulnerable soils and to plan emergency response [http://www.njgeology.org/enviroed/hazus.htm](http://www.njgeology.org/enviroed/hazus.htm). In light of recent landslides in Washington State, the landslide database was updated to include 34 newly identified landslides since the previous 2006 publication. A risk evaluation of over 500 GPS-located abandoned iron mines in northern New Jersey was completed under a FEMA grant.

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**NEW MEXICO**

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The New Mexico Bureau of Geology and Mineral Resources, a research and service division of the university, continues to serve as the geological survey for New Mexico, as it has since 1927. Our core functions include research on the geologic framework of the state, including basic geologic mapping, evaluation of New Mexico’s energy, mineral, and water resources (with an eye toward their prudent development), archiving and dissemination of data, as well as public education and outreach. We have a long history of working collaboratively with faculty and students in the academic division. Increasingly we seek outside funding from grants and contracts to support our projects, and invariably these projects involve students from across campus. Eighteen members of our research staff serve as adjunct faculty, teaching courses at the 400- and 500-level that would otherwise be unavailable to NMT students.

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**GEOLOGIC MAPPING AND FIELD STUDIES**

In the coming year the bureau will continue its statewide geologic mapping efforts, with a focus on watersheds that provide water to areas with pressing societal needs, and areas of ongoing and potential economic development. This year’s STATE-MAP award from the U.S. Geological Survey to the bureau was $163,068, among the highest awards received among the fifty states. We continue our work in the Jemez Mountains, and we are working toward completion of detailed geologic map compilations for the Mount Taylor area and the Tularosa Basin. Our work covers areas in all three congressional districts and serves a broad base of local communities and state agencies.

Detailed geologic field studies continue in many areas throughout the state. We’ve completed a detailed study in the San Juan Basin on the Mancos Shale in the subsurface of northwestern New Mexico. This was designed to quantify water resources that might be available for future development in that region. For some years now, we’ve worked with a consortium of other groups in the development of the National Geothermal Data System, and we’ve just initiated a Department of Energy-funded study of geothermal resources of southern New Mexico. Our study of rare earth element resources in the state is ongoing.
HYDROGEOLOGY

The bureau’s aquifer mapping program continues to work on groundwater issues statewide. Funding for this program, which has come to us as a separate line item for years, has now been incorporated into our base budget. This year we also received financial awards from the Water Resources Research Institute (WRRI) at New Mexico State University to collaborate on a statewide water assessment. This will address water level changes in several basins across the state, using data from the U.S. Geological Survey, the New Mexico Office of the State Engineer, and the New Mexico Bureau of Geology. We are also working to identify areas of potential recharge for the state. Using ArcGIS models, we are combining multiple datasets, including results of recharge estimates from previous work, estimates of precipitation, land surface elevation, potential evapotranspiration, geology, vegetation, and stream locations to identify areas of recharge. These two projects are part of a multi-agency, multi-institution collaborative effort, funded by the New Mexico State Legislature through WRRI. We continue to work on groundwater assessments in the area south of Taos, and we are currently working with a New Mexico Tech student on the impacts of mine tailings on regional hydrology and water quality in the Questa area. The bureau has been awarded a $100,000 grant from the New Mexico Environment Department to conduct focused hydrogeologic studies for small communities with endangered water supplies and to further develop our online geologic and hydrologic resources for the public. These new online resources will serve a broad constituency interested in protecting the quality and sustainability of New Mexico’s water resources. We anticipate this will be the beginning of a long-term cooperative endeavor.

Several members of our staff have been involved this past year with the governor’s Brackish Water Work Group. The goal is to develop a more detailed inventory of the state’s brackish water resources, in an attempt to quantify these resources and evaluate how they might supplement the state’s limited fresh water resources. We are working with several other state and federal agencies in this endeavor.

GEOTHERMAL PROGRAM

We completed our work on the National Geothermal Database, as well as the Jemez geothermal well. These two projects have allowed us to initiate formal geothermal investigations throughout the state, which helped us obtain additional funding from the U.S. Department of Energy. The development of a National Geothermal Data Base has facilitated progress on other geological databases within our organization. This past year we added water chemistry, temperature log, and bottom hole temperature data to the National Geothermal Data System. We routinely receive requests for data. In February, we received a special request from the State Land Office for data regarding the geothermal potential in the vicinity of the then-proposed Organ Mountains/Desert Peaks National Monument. A shallow heat flow map of Doña Ana County was generated during this collaboration with the State Land Office.

Temperature profiles were measured in a dozen wells in the vicinity of Santa Fe with students from the Summer of Applied Geophysics Experience field school. We discovered elevated gradients (74-76°C/km) in the Buckman water well field that are perhaps related to long-term pumping in the well field or to subsidence caused by excessive groundwater withdrawal in the
early 2000s. These data were presented in a poster at the 2013 AGU by one of the SAGE students.

We participated in a sustainability study of the geothermal resources in Truth or Consequences. Working with others from New Mexico Tech, we reassessed temperatures, pressures, and water levels to see if conditions have changed since 1941. Water table has dropped 1-2 ft., pressures have dropped, temperatures are approximately 4°C cooler. An estimated system discharge of about two million gallons per day is an absolute upper limit for pumping. The results were reported in Open-file report 551.

A new geothermal resource was discovered south of Caballo Lake. Two thermal profiles were measured in November 2013 and March 2014. Temperatures of 64°C at 102 m were observed in the Gillis Hot Well.

Data collected in the Lake Valley – Hillsboro area summarized in the Independent Study of master’s student Mussie Tewelde were presented at the 2013 GSA meeting, and formed the basis for a paper written in May 2014 that will be published later this year in the Geothermal Resources Council Transactions. Working with hydrogeologic models developed by Dr. Mark Person in the Earth and Environmental Sciences Department at New Mexico Tech, we learned that the geothermal system northeast of Hillsboro is best explained by deep circulation of water into the Proterozoic basement that was highly fractured during the formation of the 34 Ma Emory caldera and upwelling of the heated (80°C at 84 m) waters along a rift-related fault.

EDUCATION AND OUTREACH
We’ve worked very hard this year to increase our web presence, both in terms of what we serve the public, and how we serve it. We are in the process of developing more sophisticated web interfaces, including a map server that will allow users to geographically locate data. We currently maintain a number of complex statewide databases, and we are working to integrate these with the map server in order to make these data more accessible. In 2014 close to one million distinct users visited our web site and downloaded data from our site.

The bureau hosted 28 teachers at this year’s Rockin’ Around New Mexico, our annual 3-day teacher’s workshop. This year it was held in Silver City, New Mexico, and included tours of the Santa Rita copper mine. As always, the bureau was very involved in Earth Science Week activities. We held our annual open house during that week, for on-campus students, teachers, and local citizens. We also produced radio spots that were broadcast throughout the week on KUNM, the Albuquerque Public Radio Station associated with the University of New Mexico.

Our Mineral Museum continues to attract close to 15,000 visitors annually from across the country, in addition to school groups from throughout New Mexico. We conducted tours for 1,700 students onsite and hosted 21 school groups. In addition, our annual Mineral Symposium, now in its 35th year, was held in the Fall on campus.

COLLABORATIVE RESEARCH, TEACHING, AND ANALYTICAL LABORATORIES
Our laboratory facilities continue to support research across campus, providing research funding and opportunities for both faculty and students that would otherwise be unavailable on campus. Our state-of-the-art geochronology lab is one of the top facilities in the U.S. and attracts researchers from all over the world. These facilities are operated as cost centers, are largely self-supporting, and bring in an annual income of $250,000 (in FY 14).

We collaborate with researchers across campus in acquiring research grants and contracts. Many of our researchers serve as PIs (principal investigators) or co-investigators on these grants. The presence of the bureau on campus, given its 87-year history, its reputation, and its staff, is one of the features that attract research dollars to the university. In this current fiscal year (FY15), we are supplementing our base funding with $819,418 in external funding from grants and contracts (many of these are multi-year projects). Since 2012, the cumulative total of external funding we have acquired is approximately $1.5 million. We provided $137,246 in overhead to the university in FY 14.

Eighteen of our professional staff serve as Adjunct Faculty in academic departments on campus. In FY 14, bureau employees provided instruction that generated $159,232 in formula funds. This represents 114 500-level credits. We provide direct financial support to 10-12 graduate students each year, and we employ approximately 30 undergraduates in various capacities.

HONORS AND AWARDS
Ron Broadhead, our principal senior petroleum geologist, received this year’s Distinguished Service Award from the American Association of Petroleum Geologists (AAPG), for his singular and beneficial long-term service to the organization and to the discipline.

Two members of our staff were elected Fellows of the Geological Society of America this past year. Dr. Nelia Dunbar, geochemist and deputy director, was recognized for the quality and breadth of publications and collaboration applied to magmatic volatiles, tephrochronology, volcanology, and glacial geology. Dr. William C. McIntosh, senior volcanologist and geochemist, was recognized for his exceptional research record on the geochronology and volcanology of the major provinces of western North America and Antarctica.
**THE FUTURE**

Since December 2013 we have worked closely with planners and contractors on the construction of our new 83,000-square-foot, LEED-certified facility on campus. Funding for the new building was provided largely from revenues generated by General Obligation Bond C for higher education capital improvement projects, which was approved by voters during the November 2012 election. The new Bureau of Geology building will house all of our staff and analytical laboratories, as well as the Mineral Museum, Subsurface Data Library, and Geologic Information Center. Located at the corner of Leroy Place and Bullock Street, it will occupy a prominent place on the university campus. It will also provide significant new classroom space for use campus-wide, and our work areas are equipped with facilities for student researchers. In addition to providing greater public access to all of our resources, we hope that the new building will provide support and incentive for cross-discipline collaborative efforts campus wide, and usher in a new era of research and service, both to the university and to the people of New Mexico.

**NORTH CAROLINA**

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The North Carolina Geological Survey (NCGS) was authorized by the General Assembly in 1823, making this organization the oldest state supported geological survey. Today, the NCGS is one of three sections of the Division of Energy, Mineral, and Land Resources where our mission is to serve the state by:

- Promoting the preservation of our unique geological heritage through education and outreach;
- Prevent unsafe development through hazard-mapping and public education; and
- Provide detailed geological information for sustainable land use.

The State Geologist NCGS Section Chief has the additional concurrent responsibilities: the DENR Disaster Response and Recovery Coordinator who provides situational awareness for the departmental leadership team and coordinates all disaster and recovery activities undertaken by the department; Commissioner (NC DENR Rep.), State Emergency Response Commission; Commissioner (ex officio), Mining and Energy Commission; Member (ex officio), N.C. Board for Licensing of Geologists.

There are three work locations for the survey personnel – the NC DENR Asheville Regional Office (ARO), the Coastal Plain Field Office and Core Repository and the Archdale Building in downtown Raleigh.

NCGS personnel at the ARO conduct detailed geologic mapping and mineral resources identification in the Blue Ridge Province / Western Piedmont. Support from STATEMAP permits our appropriated salaries and benefits to be leveraged to obtain receipt-supported personnel as well as reimbursement for most field costs. In addition, our senior geologist for engineering geology and geohazards assists in STATEMAP mapping as well as respond to inquiries and requests from local governments on landslides.

The Coastal Plain Office and Core Repository houses personnel from both the Piedmont and Coastal Plain STATEMAP workforce. Receipt-funded personnel work alongside the state appropriation-funded staff to conducted detailed geological mapping and mineral resources assessment. In addition, they have been asked to provide forensic analyses in a number of felony cases. A new technique to use micro-probe analysis of minerals as trace evidence has been presented in several felony murder cases.

The geologists at the Archdale Building have remained busy throughout the year in promoting earth science education, detailed geologic mapping in the Piedmont, and research on the geological assessment of the shale gas potential of the Mesozoic basins in the state.

In June 2013, the N.C. General Assembly allocated $300,000 to the NCGS to conduct a number of investigations on characterizing the shale gas potential in the Deep River and Dan River basins. Work has been completed on geomechanical, mineralogical, and porosity characteristics of the rocks in both basins. The complete publications list of our natural gas publications can be found on our website at: [http://portal.ncdenr.org/web/lr/geological_home](http://portal.ncdenr.org/web/lr/geological_home), and click on the “oil and gas research” tab.

There were two changes in the NCGS in 2013–2014. Mr. Philip Bradley was promoted to Assistant Section Chief and moves from the CPO-CR to the Archdale Building. He will continue to devote a significant amount of his time to detailed geologic mapping in the Piedmont Province. Another promotion was for Nick Bozdog, a temporary geologist who moved to fill the Project Geologist position for the Blue Ridge Province that had been filled earlier by Bart Cattanach, who was promoted to Senior Geologist for the Blue Ridge Province.
The North Dakota Geological Survey (NDGS) serves as the primary source of geological information in the state of North Dakota. The North Dakota Century Code lists sixteen responsibilities for the NDGS, including: 1) investigating, describing, and interpreting the geology of the state with special emphasis on the economic minerals, geologic hazards, energy resources, and the impacts of geologic conditions on the health and safety of the citizens and environment; 2) to maintain a public repository for fossil and rock specimens, rock cores, and well cuttings; and 3) aid in the regulation of the state’s mineral resources.

The NDGS was established in 1895 under the administrative guidance of the State Board of Higher Education. The State Geologist also served as Chairman of the Department of Geology at the University of North Dakota in Grand Forks. This dual role was maintained until 1985. In 1941, ten years before oil was discovered in ND, the Survey was charged with enforcing the oil and gas conservation law for the North Dakota State Industrial Commission (the Governor, Attorney General, and Agriculture Commissioner). The NDGS was given authority over the state’s subsurface mineral program in 1969, through which we regulate the exploration and production of all minerals other than oil and gas, coal, and sand and gravel. We also regulate coal exploration (since 1975) and geothermal energy production (implemented in 1984). In 1981, the ND Industrial Commission Oil and Gas Division was split from the Geological Survey. In 1989, the Geological Survey was placed under the ND State Industrial Commission and moved to Bismarck. In July 2005, the Geological Survey became a division and both it and the ND Oil and Gas Division were placed within the newly formed Department of Mineral Resources (DMR). The State Geologist is director of the Survey and an assistant director within the DMR. The State Geologist reports to the Industrial Commission on a quarterly, or as needed, basis.

The NDGS shares an office and warehouse with the ND Oil and Gas Division in Bismarck. We also maintain the Johnsrud Paleontology Laboratory in the North Dakota Heritage Center (state museum) in Bismarck. The NDGS operates the Wilson M. Laird Core and Sample Library on the campus of the University of North Dakota in Grand Forks.

**BAKKEN AND THREE FORKS PROJECTS**

We continue to focus a substantial part of our subsurface studies on the Bakken Petroleum System (lower Lodgepole, Bakken, and Three Forks Formations—Mississippian and Devonian). In addition, during this time we also published posters, maps, and reports on Deadwood-Winnipeg (Cambrian-Ordovician), Icebox (Ordovician), Red River (Ordovician), and Tyler Formation (Pennsylvania). We collected 800 core and cuttings samples from these rock units and had them analyzed for TOC, RockEval, and activation energy.

**TEMPERATURE PROJECT**

We received funding to purchase a temperature probe to run in temporarily abandoned oil wells in order to obtain accurate subsurface temperatures in the Williston Basin. We plan on running the probe to depths of 10,000 feet. The data, along with thermal conductivity values, will be used to refine calculations on oil maturation in the basin. We anticipate logging the oil wells in the fall.

**GEOLOGIC MAPPING**

For the fifth year in a row we did not participate in STATEMAP so we could maintain flexibility in our mapping program. We initiated a mapping program in the Williston area (northwestern North Dakota) and another in northeastern North Dakota.

**PALEONTOLOGY PROGRAM**

The NDGS manages North Dakota’s fossil resources through development of the State Fossil Collection (established in 1989). We accomplish this by monitoring paleontological activities on public lands, by performing paleontological assessments of lands being impacted by ground disturbing activities, and by conducting paleontological investigations. The State Fossil Collection is housed in the Clarence Johnsrud Paleontology Laboratory in the North Dakota Heritage Center. The State Fossil Collection contains millions of fossils including microscopic specimens such as pollen grains and foraminifera as well as leaves, clams, snails and tens of thousands vertebrate fossils (Cretaceous dinosaurs, Tertiary mammals, Ice Age mammals, etc.). Our paleontologists supervised five public fossil digs again this summer after having to curtail the digs in order to complete installation of the new Geologic Time Gallery in the recently expanded state museum. The Geologic Time Gallery opened April 25. After having spent two years in temporary office space, our paleontologists are in their new office space with two greatly expanded laboratories and a major fossil collection storage area.

**WILSON M. LAIRD CORE AND SAMPLE LIBRARY**

Our core and sample library is located on the campus of the University of North Dakota. The 15,000-square-foot facility contains roughly 80 miles of core. In addition to the cores and samples, we have approximately 16,000 thin sections that oil companies, consultants, and students have made from these cores. We have photographed each thin section as well as 116,000 feet of core and placed those photos on the Oil and Gas Subscription site. In addition, the NDGS has recently reboxed 301,000 feet of core in an effort to save space and extend the life of the core and sample library. Reboxing has resulted in a space savings of 30% because the new boxes can be more tightly stacked and the core more tightly packed. We completed reboxing standard core boxes and have switched our focus onto flat boxes. Had we not initiated this aggressive project, the facility would have been totally full four years ago. We hired an architectural firm with the $25,000 our state legislature gave us and have plans for a $16 million core library expansion that we will take to the legislature in January. If approved, we will expand from one laboratory to five and the warehouse will expand to house an additional 50 years of core storage.
REGULATORY PROGRAMS
The North Dakota Geological Survey regulates coal exploration, subsurface mineral exploration and production, the Class III wells in the underground injection control program, geothermal production, and paleontological resource assessment permits on state owned land. Over the past 12 months, we issued 114 geothermal permits. The majority of these permits were for residential, closed-loop geothermal systems.

EARTH SCIENCE OUTREACH
We produce a variety of educational materials—guidebooks, maps, non-technical publications, and exhibits. We work with schools, providing various kinds of earth-science information. During this twelve-month period, our geologists gave 111 presentations and answered more than 3,100 enquiries. In addition to the traditional service club breakfasts and luncheons, schools, and technical conferences, we also give tours of our paleontology laboratory and core workshops of oil reservoir rocks. Typically, half of our outreach is through our paleontology program, but we were in a temporary lab space during most of this time and had to curtail our laboratory tours. For the last nine years, we have staffed a booth at the North American Prospect Expo (NAPE) in Houston, Texas. Hundreds of attendees typically stop by our booth during the two-day event to discuss the oil and gas posters we have created for the event. In June we co-led a fieldtrip for the North Dakota Petroleum Council’s annual teacher seminar and gave a presentation on the state’s lignite resource at a teacher seminar sponsored by the North Dakota Lignite Energy Council. Approximately 200 teachers attended these seminars.

EARTH SCIENCE INFORMATION CENTER
The NDGS maintains a complete collection of USGS topographic maps and land-management maps for sale to the general public. We oversee the state’s Digital Data Clearinghouse, which contains DEM, DRG, DLG, DOQQ and other information on the web for access by other state and federal agencies and the general public. Sales of paper topographic maps continue a slow decline due to the availability of digital files of these maps on the North Dakota GIS hub. Over the years, we have purposely kept our publication fees low and have distributed large numbers of our publications, without charge, to other state agencies, schools, visitors, etc. Some series, such as our county bulletins, newsletter, and postcards are free to the public. In addition, we have placed all of our out-of-print publications and most of our Geologic Investigations series onto our website so that they can be downloaded for free.

GPS COMMUNITY BASE STATION
The NDGS chairs North Dakota’s Global Positioning Satellite (GPS) Steering Committee, a public-access site. The base station was established by the NDGS in 1993 for state and federal agencies and was available to others on a subscription basis before it was offered freely to the public. The site is part of the National Geodetic Survey’s Cooperative CORS (Continuously Operating Reference Station) network.

GEOLOGIC REVIEWS
The NDGS does a number of environmental reviews, as well as paleontological and mineral assessments for both state and federal agencies. We review municipal and industrial solid waste permits, coal mine permits, highway construction activities, and assess the geologic suitability of transmission line and pipeline corridors. When requested, we assess the mineral potential (oil and gas, coal, sand and gravel, etc) on State Lands.

GEOLOGIC PROJECTS
We are working on a number of additional projects including: 1) potash resources of the North Dakota portion of the Williston Basin, 2) several paleontological articles regarding Cretaceous and Paleocene marine vertebrates, 3) landslide mapping in north-central and southwestern North Dakota, 4) a series of Paleozoic to Cenozoic cross sections throughout eastern North Dakota, 5) co-management of the fossil resources of an area that was deeded over to the State of North Dakota, 6) gamma ray logging of selected core in our core library, 7) and the glacial stratigraphy of the Red River Valley.
The Ohio Department of Natural Resources (ODNR), Division of Geological Survey was established in 1837 and has been continuously authorized since 1869. The Division’s mission is to provide geologic information and services needed for responsible management of Ohio’s natural resources. It researches and reports on the geology of the state and is Ohio’s archive for geologic information. Main offices are located on the ODNR main campus in north Columbus and at the Horace R. Collins Laboratory at Alum Creek State Park. The Division’s staff of 25 provides technical expertise to citizens, industry, and other agencies of government concerning coal, oil and gas, minerals, and geologic hazards. During FY 2014 reporting period, the Division’s budget consisted of severance tax income on fuel and non-fuel commodities, federal and state grants, departmental-allocated funds, and income generated from the sale of publications, maps, and data. All General Revenue Funds were eliminated in FY 2011—effectively a 55 percent budget reduction at that time. Increased oil and gas production from the Utica-Pt. Pleasant shale play and strong sales in road salt due to the severe winter have helped bolster the severance tax significantly over the last few months.

The Division is organized into five groups: Administration, Energy Resources, Geologic Mapping and Industrial Minerals, HRC/Lake Erie Science (“Hercules”), and Publications and Geologic Records Center.

**ADMINISTRATION**

Administrative Assistant Ronda Tipton and Fiscal Officer Pattina Collins-Paisley were transferred to other divisions within the Department as part of the centralization of support personnel and services.

**ENERGY RESOURCES**

Dr. Mohammad Fakhari was hired in March 2014 as the Supervisor for this group after a lengthy search. Mohammad brings great enthusiasm and professionalism to the group and serves as a good mentor to the younger staff being brought on board. Senior Geologist Ron Riley remains heavily involved with research and grant efforts. Senior Geologist Mark Baranoski continues his research on Ohio’s deepest rock units, investigating the Cambrian and pre-Cambrian stratigraphy. Over the past three months, geologist Dominique Haneberg-Diggs was hired to help process, analyze, and interpret seismic profile lines and geophysical logs. Geologist Technician Jeff Deisher was added to work on scanning geophysical logs, create .LAS files, and to perform as a field liaison. The Division is putting in a proposal to ODNR Administration to help cover costs to purchase software, hardware, and personnel to adequately process (or reprocess), analyze, and interpret geophysical profiles and data. Geologist Matt Erenpreiss continues research on the Utica Shale and Devonian-age shale geochemistry. Geologist Michael Solis continues to improve mapping based on both geophysical logs and seismic profiles. He is also leading the Division’s efforts to move from our aging GeoGraphix Software to Petra/Kingdom suite products. Michael and Dominique have been working with Wright State University in Dayton to help learn new mapping and interpretative techniques. Geologist Paul Spahr has been working on revising the USDW map, which is crucial to the drilling community and helps with a number of GIS applications. The group also supports the oil-and-gas industry by mapping and characterizing existing and potential oil-and-gas fields and deep subsurface geology for injection and sequestration.

Energy Resources Group activities included work related to gas shale development in the state, particularly the Utica-Pt. Pleasant interval. As an example, the group has submitted a final report associated with the Utica Consortium, which included the Geological Surveys of West Virginia, Pennsylvania, and Kentucky and whose aim is to collaborate on research projects related to the Utica-Pt. Pleasant interval. In support of the consortium, the Division analyzed core with a Spectral Gamma Logger, described and photographed core, digitized geophysical logs, and created related LAS files. Increased production of oil and gas from the Utica-Pt. Pleasant horizontal wells will significantly impact the severance taxes distributed to the Division and will continue to be an important focus for the group for decades. The group also helps review the geologic framework for both Class I (hazardous waste) permits for the Ohio EPA and for Class II (oilfield brine) injection well permits for the ODNR Division of Oil & Gas Resources Management (DOGRM). The group’s research on improving the USDW map and updating the length of well casing needed for drilling is also being conducted in association with DOGRM. This project will include sampling select drilling sites and depth intervals to help improve the map and supporting databases. Additionally, the group is working on a Research Partnership for Securing Energy in America (RPSEA) grant, which is targeting formations for brine and drilling fluid disposal in the Appalachian Basin.

The Energy Resources Group continues to research carbon sequestration by participating in the nine-state Midwest Regional Carbon Sequestration Partnership (MRCSP). The MRCSP research centers on cooperative work with The Ohio State University, School of Earth Sciences SEMCAL Laboratory in which Division staff conduct analyses for Ohio and surrounding member states. The group is also assisting the Kentucky Geological Survey with its research on the Berea as a possible unconventional target for hydrocarbon development. Ron Riley is involved with a project funded by the Ohio Coal Development Office and managed by Battelle that researches historically depleted oil-&-gas fields that might prove suitable for future CO2-based, Enhanced Oil Recovery (EOR) operations.

**GEOLOGIC MAPPING AND INDUSTRIAL MINERALS**

In 2013, this group was split into two groups to better serve the needs of the Division. The sections include the traditional Geologic Mapping and Industrial Minerals Group and the newly formed HRC and Lake Erie Science (HRCLES or “Hercules”) Group. Staff geologist Rick Pavely has been temporarily leading work for the STATEMAP and Great Lakes Geologic Mapping Coalition projects. Group geologists Frank Fugitt and Douglas Aden
are focusing on mapping surficial/glacial deposits, developing GIS layers and tools for this mapping, and working on geohazards including karst features and abandoned underground mines (AUMs). Geologist Lee Sorrell was hired in March 2014 to work on a coal resource grant funded by OCDO. The plan is to have Lee eventually oversee the Division’s coal-based research both as a resource and as a geohazard for mine subsidence. Senior Geologist Mark Wolfe continues to compile information on industrial mineral and coal production and sales to produce the 2013 Report on Ohio Mineral Industries. Geologist J. D. Stucker was hired in June 2014 to assist Mark and learn the process for compiling the report and fielding numerous public service requests relating to these topics.

The STATEMAP-funded project to produce a 1:100,000-scale, three-dimensional, surficial-geology map (“stack-unit” map) of the western half of the Hillsboro 30 x 60-minute quadrangle was completed in September 2014. The STATEMAP-funded, surficial-geology mapping began in 1998 and 90 percent of glaciated Ohio has been remapped.

Surficial-geology mapping activities conducted through the Great Lakes Geologic Mapping Coalition focused on digitally produced, detailed karst location maps of the Bellevue region of northwestern Ohio using LiDAR and GIS technology. This work, compiled by Douglas Aden, covered the Fireside and Flat Rock 7.5 minute (1:24,000) quadrangles. Detailed surficial mapping was compiled for the Rainsboro 1:24,000 quadrangle in southwestern Ohio. The mapping group also finalized the deliverables for the AASG-sponsored National Geothermal Data Systems project. Dr. Tim Leftwich was PI on this project and retired in early 2014; Mark Wolfe and Frank Fugitt are working on a summary report of the findings from the work. Ohio is splitting efforts between deep geothermal potential energy and shallow ground-source heat pump technology systems. Along the latter area, the Division has been looking into the potential of using AUMs as potential reservoirs for geothermal heating/cooling applications.

H.R. Collins and Lake Erie Science (HRCLES) “HERCULES GROUP”

The Division administration created a separate group from the Mapping and Industrial Minerals Group to focus better on the activities at the H. R. Collins Core and Sample Repository (HRC). D. Mark Jones is the supervisor of this group, which includes three other full-time geologists and one intermittent geologist.

The HRC continued to acquire core and sample collections to augment the 300,000,000 linear feet of core currently at the facility. A fee schedule was created in FY12 to recoup costs of the extensive sampling on the Utica Shale being performed by shale gas companies. The bulk of this research has migrated from industry to academic-related research. Geologist Aaron Evelszor manages the daily operation of the facility and has taken on a campaign to help promote the facility to outsiders.

The HRC received a much-needed facelift thanks to departmental capital improvement monies that were allocated in the summer of 2013. Major changes were made to the large classroom area, lobby/vestibule area, and employee offices. The net result is the facility has been greatly improved as an area for public meetings, presentations, and displays. These improvements should result in substantial savings in heating and cooling costs for the facility.

Files and maps at the HRC are being organized and scanned to create a Lake Erie Data Center and a data archive for Division information. Research boats and equipment affiliated with Lake Erie research are also housed at the HRC. Records Officer Cindi Flanagan, assisted by new hire Geologist Technician Brittany Parrick, is making inroads in archiving and cataloging the vast number of maps, charts, files, and digital records associated with the former Lake Erie Geology Group. Research on Lake Erie Coastal processes included a NOAA-funded Textural GIS grant, where bluff composition was compared against transects depicting shoreline recession. The goal was to calculate the amount of sediment added to the sediment supply for the lake along the areas of eroding shorelines. This data will help predict formation or loss of beaches, effectiveness of shore protection, and other related factors along the coastline. This project was completed in December 2013. During the summer of 2014, field research centered on conducting bathymetric profiles (soundings) of the lake bottom in nearshore environments. Combined with bottom sampling, this data will be used to determine changes in the sediment budget and sand migration in these active environments.

The Ohio Seismic Network (OhioSeis), headquartered at the HRC, monitored earthquakes in the state using its network of 29 volunteer-run stations. Dr. Michael Hansen has been with the Division for over 40 years and continues his veteran leadership of the OhioSeis program. Upon the retirement of Dr. Tim Leftwich in March, geophysicists Jeff Fox and Daniel Blake were hired to better assist Dr. Hansen with OhioSeis-related activities. The OhioSeis program has made great strides at implementing new IT developments, seismometers, data downloading, storage, and archiving. The OhioSeis group is visiting a number of the OhioSeis network stations to check functionality and to determine and recommend likely sites that can be upgraded to higher-technology, more sensitive seismometers. The Division purchased four highly sensitive, three-channel, portable seismometers that can be deployed on short notice to detect aftershocks. This information will allow for better analyses of individual events. The Division also purchased two NetQuake seismometer units that will be tied into the USGS national system. These units provide a trigger notification via e-mail if an event is recorded. The OhioSeis staff has also been working with the U.S. Transportable Array (EarthScope) network, which has proven very valuable in locating seismic events. The Division is purchasing three of the TA stations in eastern Ohio to help insure that this valuable monitoring continues.

Publications and Geologic Records Center (Formerly Technology Transfer Group)

GIS Supervisor Jim McDonald, database administrator Joe Wells, and GIS specialist Rob Hanover were all transferred to the ODNR Office of Information Technology (OIT) in January 2014 as part of a departmental centralization plan. They still have the ability to perform much of the final GIS and database work and cartography the Division needs; this is accomplished by routing such work in the form of a work request charter or contract through OIT. So far most of the Division’s project needs are being addressed. The group will continue providing valuable support for the MRCSP, STATEMAP, and other critical projects.

This group is responsible for the final editing, layout, production, and release of reports and maps. It also updates the Division website, creates IMS products, scans records, and designs databases. Technical editor, Chuck Salmons, and graphic
design specialist, Lisa VanDoren, have excelled at producing professional quality publications, posters, displays, announcements, proposals, and other short-term products. Lisa has been centralized into the Creative Services Section of the ODNR Office of Communications, but she continues to focus most of her time on Division projects. Dave Orr, who is on loan from the Creative Services section of the Office of Communications, provides technical web support. Geologist technician Brittany Parrick was hired by the group to provide support for a number of the tasks in this group and covering OIT and database tasks. A particular success this year was the release of Information Circular 63: Ohio's Geology in Core and Outcrop—A Field Guide for Citizens and Environmental and Geotechnical Investigators. This document has generated considerable interest in the Division, favorable comments, and sales. The group is also finalizing lengthy edits to a complete revision of Bulletin 69: Minerals of Ohio. The second edition will contain many updates, will be in full color, and will be hard-bound. The Geologic Records Center (GRC) is the Division’s direct connection with Ohio citizens and industry. Maps, geologic records, and data are made available to walk-in and online customers as well as via phone and e-mail requests. Custom geologic maps are produced for customers on demand through an innovative GIS map application. These maps have proven especially popular with the oil-and-gas industry. Income from the sales of maps, reports, and digital information was over $127,400 for this report period.

**OKLAHOMA**

**Oklahoma Geological Survey**

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The Oklahoma Geological Survey is a state agency for research and public service located on the Norman Campus of the University of Oklahoma and affiliated with the OU’s Mewbourne College of Earth and Energy. The Survey is chartered in the Oklahoma Constitution and is charged with investigating the State’s land, water, mineral, and energy resources and disseminating the results of those investigations to promote the wise use of Oklahoma’s natural resources consistent with sound environmental practices. The Survey is not a regulatory agency.

**NEW PUBLICATIONS AND PROGRAMS EXAMINE SOUTHERN AND SOUTHWESTERN OKLAHOMA**

*The Wichita Mountains in Oklahoma: Their Story Through Time* by Dr. M. Charles Gilbert, has been released by the Survey as Guidebook 39. The 44-page book includes many great photographs of the area, GPS locations and stop descriptions for 15 stops, a geologic time scale, an outline of the igneous stratigraphy, a guide to minerals and rocks, simplified stratigraphic column, and an introduction and summary that give readers a thorough background on the geologic history of the mountains and their surroundings.

Dr. Gilbert has spent many years working in the Wichitas and his enthusiasm for them is evident in this publication. He intended the book to be useful to the general public as well as to beginning geologists, students, and professional geologists. He also helped in a project, mentioned below, to place new informational signs on hiking trails in the area. It is a popular spot for recreational use, and this book and the signs are welcome additions for the many visitors that enjoy the area. Guidebook 39 is available for $10, and will soon be available to view on the OGS website.

**Igneous and Tectonic History of the Southern Oklahoma Aulacogen**, OGS Guidebook 38, was in the very final stages of printing and binding as this report was written. The publication represents a major effort for the OGS and Dr. Neil Suneson, who edited the volume. This 405-page book measures 1 in. thick, and is printed on high-quality paper in a large format that allows ample room for good-sized color photos and illustrations. The price of the book is $35.

The guidebook is an outgrowth of an OGS field conference held in March, 2014. All 8 of the stops from that two-day field trip are written up in the guidebook, along with an additional 15 original research papers on various aspects of the Southern Oklahoma Aulacogen. The stops on this field trip focused on the igneous rocks of the Arbuckle Mountains and Wichita Mountains. The trip leaders are the experts in those areas, and are the authors of the stop descriptions for the book. A total of 37 people attended the field trip, coming from as far away as
Ottawa, Canada, Pittsburg, PA, and Houston, TX.

The book is a tribute to Rodger E. “Tim” Denison, a 1954 and 1969 graduate of the University of Oklahoma and former Oklahoma Geological Survey employee who has spent much of his career in the study of Oklahoma geology. He was one of the authors of Basement Rocks and Structural Evolution of Southern Oklahoma, OGS Bulletin 95, a 1964 publication that is widely cited by those studying the southern mid-continent. Tim’s often humorous account of the making of Bulletin 95, and his own history, is included in the guidebook. The group was fortunate that Tim attended the field trip and was able to share his insights from nearly 60 years of work in the area.

**Oklahoma Rocks! What Lies Beneath!** In addition to these two guidebooks, to complement and extend its studies of the areas covered by these new publications, the Survey is at work on its sixth edition of OKLAHOMA ROCKS! This offering is OKLAHOMA ROCKS! What lies Beneath!, and will examine the rocks and structures below Oklahoma, in particular the formations of the Ouachitas, the Wichitas, the Southern Oklahoma aulacogen, Anadarko basin, and Meers fault. This is part of the Daily Oklahoman’s Newspapers in Oklahoma program that provides 25 paper copies of a 12 to 16 page workbook, a teacher’s guidebook, lessons and various activities and projects at no cost to classrooms across Oklahoma. This project will be issued in the fall of 2014, and will be and available also, along with all past issues of OKLAHOMA ROCKS!, on the NIE website under the Curriculum tab, then Previous Programs. [http://nie.newsok.com/educators/crriculum/](http://nie.newsok.com/educators/crriculum/)

**Burbford Lake Trail Signs.** Also in this area of the State, the Survey cartographic department and Dr. Neil Suneson worked in cooperation with the Red Earth Desk and Derrick Club, the ConocoPhillips School of Geology and Geophysics at the University of Oklahoma, and federal government naturalists to make new interpretive signs for the geology seen along the Burbford Lake Trail in the Wichita Mountains Wildlife Refuge in southwestern Oklahoma. The signs are built to withstand weather and animals and will be enjoyed by visitors for many years to come. Also instrumental to this project was Dr. M. Charles Gilbert, a retired geologist, long-time OGS collaborator and author, and former professor and director of the OU School, who has extensive expertise in the Wichitas. Dr. Gilbert’s enthusiasm for the area is evident in OGS Guidebook 39, which is mentioned above, and in this project.

Fortunately, the geology along the Burbford Lake Trail is well known and well exposed. The Wildlife Refuge has some 1.7 million visitors per year, and is the third-most-visited refuge in the U.S. The area is famous because of its excellent camping facilities, hiking and rock climbing venues, wildlife (bison, longhorn cattle and prairie dogs) and scenery, especially the drive to the top of Mount Scott.

**SEISMIC STUDIES**

Earthquakes continue to be the topic of much study and interest as quakes became even more frequent in populated areas near and in Edmond and Guthrie, just north of Oklahoma City, and close to Ponca City and Stillwater. Requests for media interviews and speakers come to OGS now from around the world as well as local media and civic groups, and in far greater numbers than the staff could possibly accommodate.

Upgrades and additions to the seismic network will help the Survey research the activity and gain far better understanding of the mechanics at work underneath the State. Funding through RPSEA will help address questions with respect to geologic conditions, monitoring and predictive modeling necessary to evaluate potential causes of this increased seismicity. The Survey is building, testing, and updating volumetric (ED) geologic interpretations based on information from existing well and well-log databases, rock-mechanics data, rock properties and seismic imaging. This will be tested against existing and newly acquired gravity data as well as the ongoing seismic monitoring. The geologic interpretation will be examined along with production and water disposal information, as well as reservoir and rock mechanics modeling to look at changes through time associated with oil and gas production, while incorporating additional information dimensions (4D) to enhance the study.

In response to the growing work load surrounding these earthquakes and the potential for induced seismicity, additional staff members have been added to help with seismological work: Amberlee Darold and Jennifer Morris are now analyzing data, installing seismographs and helping answer questions about the earthquakes.

**ENERGY**

A new petroleum geologist was hired by the Survey in this time frame. Stacey C. Evans, who graduated from the University of Oklahoma with an M.S. in geology in 2011, joins the staff coming from her job as an exploration geologist with Concho Resources in Houston. She also has experience with Apache Corp. in Houston, and Chesapeake Energy in Oklahoma City. Her previous Oklahoma experience will serve her well at the Survey, as she joins Rick Andrews in the petroleum section.

As the issue of oil and gas activities and induced earthquakes continues to make the news, and the Survey again spent a good amount of time and staff energy during this fiscal year fielding questions from the public and the media about production and other issues related to the industry itself and the seismic activity. As a service to the state, the OGS also continued its technical meeting program with the following:

- The Fluid Injection Induced Seismicity Workshop held on July 16, 2013 had 73 attendees.
- The Oklahoma Shale Gas & Oil Workshop had 203 attendees November 20, 2013.
- The Oklahoma Shale Gas & Oil Field Trip on November 19, 2013 had 30 attendees.
- Shale Gas Field Trip held on November 21, 2013 had 34 attendees.

Many public service requests arrive each year at the OGS, from in-state and out. A sampling of petroleum-related requests would include drilling activity, hydrocarbon potential and production, nomenclature, and general geologic information. Sometimes the requests can be answered by e-mail or phone call, but some require limited data transfers, personal consultations or mail.

**GEOThERMAL**

Dr. Julie Chang continues her geothermal studies at OGS to help in understanding heat production generated from Precambrian igneous and metamorphic rocks from the Arbuckle Mountains, and Cambrian granites from the Wichita Mountains. The data greatly enhance knowledge of Oklahoma’s geothermal resource potential and have been submitted to the State Geothermal Data
project. These data, as well as all geothermal information compiled for the state of Oklahoma, are available to the public at the National Geothermal Data System website (http://geothermaldata.org). Additional heat production information is being reported as new data become available.

**MAPPING**

Mapping: STATEMAP, with Dr. Tom Stanley and Dr. Julie Chang, marks its 17th anniversary in 2014. The produced maps are part of the ongoing effort to create a new 1:500,000-scale geologic map of the state. More than 42 detailed 7.5’ geologic maps at a scale of 1:24,000 and 17 reconnaissance maps at a scale of 1:100,000 are complete and available on the website and in hard copy upon request. Detailed, 1:24,000-scale, mapping of the Ada Metro Area is currently in progress. The Vanoss 7.5’ quadrangle was mapped in 2014, and the Roff North 7.5’ quadrangle will be mapped in 2015.

Mapping of 1:100,000-scale maps is progressing with a northwest to southeast sweep of the state. The Tishomingo and Oklahoma part of the Sherman 1-degree sheets (1:100,000) were mapped in 2014, and the Pawhuska 1-degree sheet will be mapped in 2015.

Dr. Stanley also serves as an Adjunct Professor for the ConocoPhillips School of Geology and Geophysics.

**NOMENCLATURE COMMITTEE**

Because the state of Oklahoma does not have an official guide or chart showing the formally accepted positioning, classification, and nomenclature of stratigraphic units in Oklahoma, OGS has created an Oklahoma Stratigraphic Nomenclature Committee to reconcile existing nomenclature issues, review proposed changes, and create an up-to-date stratigraphic guide and chart for the State of Oklahoma. All resulting publications will be available on the Oklahoma Geological Survey’s website.

The committee is chaired by OGS geologist Brittany Pritchett. The objective of the committee is to review, update, and standardize the stratigraphic nomenclature for Oklahoma, develop and publish formal stratigraphic guides and charts for each geologic province in Oklahoma, and create a Lexicon of Geologic Names of Oklahoma after the formal stratigraphic guides and charts have been published.

**HYDROGEOLOGY**

Dr. Kyle Murray represents the OGS in many ways. In addition to his research, he attends many professional and government meetings, conferences and working groups, but still manages to find time to speak to school and civic groups about important water issues facing the state. He also is very involved with the Mewbourne College of Earth and Energy studies of water, and assists in planning the Water Innovation Research Laboratory at OU, which is a $15 million building project to accommodate space for core water quality and analytical studies, as well as more research labs, office, educational and outreach areas. His projects include compiling data on injection and produced water wells, examining nitrate levels in the Rush Springs Aquifer and evaluating changes there, and studying arsenic and chromium levels in Oklahoma water. His studies involve both ground and surface water.

His basic studies examine the interplay of water among conventional, unconventional, and renewable energy resources. In fulfilling the Survey’s Constitutional mission, his research is designed to provide practical scientific perspectives on water issues and to influence responsible management and sustainable practices.

**ONGOING RESEARCH**

Ongoing research at the OGS includes: Brian Cardott’s studies of vitrinite and coal-bed methane, and gas shale completions; CO₂ sequestration; study and mapping of Oklahoma deep structures; non-fuel mineral investigations; and coal studies.

**OUTREACH**

The OGS staff is very mindful of its responsibility to public service, and as such: Answers many questions by phone or in person; maintains an active website; helps supply needed maps and data to the public and other agencies; is involved in educational activities and school visits; cooperates with the Mewbourne School in teaching and field camp activities; organizes and leads field trips; and fills many other roles to help inform and educate the public about Oklahoma’s geology and its use and conservation.
Oregon
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The Department of Geology and Mineral Industries (DOGAMI) increases understanding of Oregon's geologic resources and hazards through science and stewardship.

The Agency's mission is to provide earth science information and regulation to make Oregon safe and prosperous.

Our Geological Survey & Services program develops maps, reports, and data to help Oregon manage natural resources and prepare for natural hazards such as earthquakes, tsunamis, landslides, floods, volcanoes, and coastal erosion. Our Mineral Land Regulation & Reclamation program oversees the state's mineral production, and works to minimize impacts of natural resource extraction and to maximize the opportunities for land reclamation.

An independent executive agency of the State of Oregon, DOGAMI assists in the development of state policy related to geologic materials, natural resources and hazards, as well as policy related to mining, oil, gas and geothermal exploration, production, conservation and reclamation.

Our current funding ratio is 17 percent State general funds, 29 percent federal funds, and 54 percent other funds. Limited general fund support has led the Agency to seek partnerships with local, state and federal governances and organizations that need our services. Our business plan can be best defined as mission-critical projects.

GEOSPATIAL DATA COLLECTION, COMPILATION, AND DISTRIBUTION

DOGAMI and the Oregon Lidar Consortium have since 2007 been working toward an ultimate goal of providing high-quality, high-resolution lidar coverage for the entire state. The state's lidar coverage expanded significantly in 2013, as data for Klamath County, the Rogue Basin area, and portions of Union, Umatilla, Baker and Wallowa counties was added. Over 19 million acres of data have now been collected, covering 94 percent of the state's population and 31 percent of the state's area. A collection status map is online here: http://www.oregongeology.org/sub/projects/olc/. Our online data viewer for bare earth DEMs can be searched by address: http://www.oregongeology.org/sub/lidarda-taviewer/index.htm.

As interest in the many practical applications of lidar continues to grow, DOGAMI has successfully leveraged the state's modest initial investment in lidar acquisition with funds from a variety of partners, including local, state, and federal government entities and private sector and non-profits.

GEologic MAPPing AND RESOURSE ASSESSMENTS

DOGAMI completed geologic mapping for multiple areas along the southern Oregon coast as part of a multi-year project to complete coast mapping from the California border north to Coos Bay. The project is a high priority of the Oregon Geologic Map Advisory Committee, and work was supported in part by the U.S. Geological Survey STATEMAP component of the National Cooperative Geologic Mapping Program.

Surface and subsurface geologic data collected over decades provided the basis for new modeling of the Portland metropolitan areas released in December 2013. The project, funded by the National Earthquake Hazards Reduction Program (NEHRP), created three-dimensional (3D) models of shallow geology and a shear-wave velocity model of the uppermost 100 feet. These models provide a better understanding of what to expect in an earthquake, including ground shaking, soil liquefaction, and earthquake-induced landslides. To see the news release: http://www.oregongeology.org/pubs/nr/press-release-2013-12-27.pdf

DOGAMI also published in December 2013 the Thermal Infrared Information Layer for Oregon (TIRILO-I). The data were gathered as part of the geothermal resource thermal gradient research in southeastern Oregon funded by the American Recovery and Reinvestment Act, USDoE funded National Geothermal Data System (NGDS) project.

COASTAL PROCESSES AND HAZARDS

With the completion of tsunami inundation maps and evacuation brochures for the entire Oregon coast, the state is now more tsunami-ready. DOGAMI developed a total of 131 new maps, including 89 new tsunami inundation maps and 42 new evacuation maps. Mapping was fully complete in August 2013. Inundation scenario data were released in October 2013, followed by release of model output files of maximum tsunami wave elevations, velocities, flow depths at specific locations over the course of the entire simulation, and other data in December 2014.

Oregon's coast has undergone major coastal erosion over the past century, and DOGAMI geologists are continuing to advance understanding of how the coast has and will continue to change. DOGAMI's Newport Coastal Field Office maintains the Oregon Beach and Shoreline Mapping Analysis Program (OBSSMAP) to document the spatial variability of beach change, including seasonal, multi-year and long-term changes. In 2013, the program was expanded to include new observation sites at Gold Beach, Rogue Shores, Nesika Beach and Netarts. DOGAMI in 2013 also took an in-depth look at erosion risks in Waldport, where local landowners have been concerned about ongoing erosion to beaches and dunes alongside Old Town Waldport during the past decade.

DOGAMI continues to be a cooperative partner in the Northwest Association of Networked Ocean Observing Systems (NANOOS), a cooperative venture funded by NOAA to establish a northwest regional coastal ocean observatory for the estuaries and shores of Oregon and Washington.

GEORGeology hazards MAPPING AND DATA

Oregon continues to increase its knowledge of the threat posed by great earthquakes from the Cascadia Subduction Zone. In June 2013, DOGAMI released the earthquake impact data for the Oregon Resilience Plan, which estimates the state's vulnerabili-

More than 46,000 known landslide locations are now included in the Statewide Landslide Database for Oregon (SLIDO). In April 2014, DOGAMI released version released SLIDO version 3.0, which compiles all landslides that have been identified on published maps. Use of lidar has dramatically expanded landslide knowledge. Nearly 20,000 landslides mapped since 2009 have come from geologic and landslide mapping that used lidar. The Agency’s 2013-2014 landslide studies also include mapping and analysis for the cities of Astoria, Vernonia, and Harbor Hills, parts of Washington County and most of Clackamas County.

DOGAMI continues to work with FEMA to revise Flood Insurance Rate Maps (FIRMs) and develop of maps and web tools for understanding exposure to flood hazard. FIRM revision, which also involves outreach to communities as they review the maps for incorporation into their flood hazard ordinances, is currently underway in three northern coastal counties.

### OUTREACH & EDUCATION

Developing new ways for Oregonians to access and connect with information on our state’s geology, natural hazards, mineral resources and more is an ongoing priority. Our website, [www.oregongeology.org](http://www.oregongeology.org), with its many interactive maps, had more than 200,000 visitor interactions between June 2013 and July 2014. DOGAMI in 2014 began offering its popular geologic guide and recreation map series two ways—with water-resistant paper maps or as mobile maps through the PDF Maps app for Apple and Android.

Creating partnerships to increase awareness of geologic hazards and opportunities is another agency priority. For example, we worked with the National Weather Service to highlight the potential for debris flows and landslides as part of flood watch warnings. 2013–2014 brought multiple debris flow warnings throughout the fall and early spring, and extensive media coverage of debris flows and all landslides as a hazard.

Extensive community engagement—on topics from Oregon’s mining history to earthquake preparedness—continues to be at the core of DOGAMI’s outreach and education efforts. DOGAMI staff reached almost 10,000 people with through lectures, presentations and other events in 2013. We also actively engaged the maritime community to develop tsunami awareness resources for boaters, and sought new venues—such as museum open houses and “science pubs”—to reach wider audiences with Agency information.

The Nature of the Northwest Information Center, where we distribute our publications and maps and books about the Northwest, both through a “bricks and mortar store” in Portland and online at [www.naturenw.org](http://www.naturenw.org), continues to successfully operate, selling more than 13,000 items per year.

### MINERAL LAND REGULATION AND RECLAMATION

Our Mineral Land Regulation and Reclamation Program (MLRR) is the lead program for mine regulation in Oregon, and works with industry and the public to minimize the impacts of mining and optimize the opportunities for reclamation. The fee-based, statewide program has the authority to regulate all upland and underground mining on all lands. MLRR oversees nearly 900 permits covering 57,250 acres. To date, more than 7,300 acres of mined land have been reclaimed and put to secondary, beneficial use. The number one issue for the program is flood-plain mining and its relationship to off-site resources, including natural habitats.

The vast majority of mining sites in Oregon are aggregate mines. In addition to sand and gravel and quarry rock, there is significant diatomaceous earth production, an industrial mineral with a variety of commercial uses. Total annual aggregate production in Oregon is approximately 52 million cubic yards. MLRR also administers for the Oregon Department of Environmental Quality the federal Clean Water Act General Stormwater Permit and the state Water Pollution Control Facility Permit at aggregate mine sites.

While there are no active commercial metal or coal mines in the state, the preliminary operating permit application process is underway for an underground gold mine in eastern Oregon at Grassy Mountain. Exploration drilling and geologic work has also occurred in far southeastern Oregon for uranium resource potential. Exploration permits have also been issued for precious and base metals in several locations in southeastern Oregon.

MLRR also regulates the exploration and development drilling for oil and gas, and geothermal. Rising interest in natural gas resources and Oregon’s Renewable Energy Portfolio Standard for geothermal energy development has led to increased activity. For example, the US Geothermal Neal Hot Springs Geothermal Power Plant in Eastern Oregon now produces 149,000 MWh of power annually, enough to power almost 15,000 homes.

As part of the Agency’s ongoing efforts to encourage best practices in mining, MLRR hosts an annual awards program for operators that recognize operation and reclamation above and beyond the requirements of regulation. Among the 2013 award winners were a state-of-the-art gold mining operation on a historic mining settlement in Baker County, an operator that continually goes above and beyond to reclaim land for agricultural use, and a quarry site project that increased creek access for spawning Coho salmon. For information on past award winners: [http://www.oregongeology.org/mlrr/awards.htm](http://www.oregongeology.org/mlrr/awards.htm).
The Pennsylvania Bureau of Topographic and Geologic Survey (aka Pennsylvania Geological Survey) has been involved in numerous projects and activities during fiscal 2013/2014. The significant activities are highlighted below, and organized by the Survey’s three divisions:

**GEOLOGIC AND GEOGRAPHIC INFORMATION SYSTEMS**

PaGEODE, bureau’s web mapping application, debuted in January. It is an online location for both the interactive display of Pennsylvania’s geology as well as free acquisition of the survey’s publications.

Three major IT projects ongoing: PaGWIS, water-well information system undergoing refurbishment. A component, WebDriller—online data collection system water-well drillers use to report well location and construction data is now live.

Pennsylvania Internet Record Imaging System/Wells Information System (PA*IRIS/WIS) undergoing reconstruction. Will move the data and operation of the system into the cloud.

Implementing complete redesign of enterprise stratigraphic database will be written to manage, query, and collect geologic data.

**ECONOMIC GEOLOGY**

Division maintained the Pennsylvania Internet Record Imaging System/Wells Information System (PA*IRIS/WIS); prepared well and geospatial data for a digital oil and gas fields open-file report in cooperation with the AAPG Foundation; completed final deliverables for AASG’s geothermal data project; conducted reservoir research in association with the Utica Shale Consortium project; continued work on the brine disposal framework research project; and continued regional geologic mapping efforts and evaluations of potential sequestration and utilization opportunities for the Midwest Regional Geologic Carbon Sequestration Partnership (MRCSP).

**MAPS AND REPORTS**

- OFMI 13-01.1 Geohydrologic and water-quality characterization of a fractured-bedrock test hole in an area of Marcellus shale gas development, Bradford County, Pennsylvania
- OFMR 13-01.0 Bedrock geologic map and coal-resource maps of the Frenchville quadrangle, Clearfield County, Pennsylvania
- OFOG 14-01.0 Using geophysical and remote sensing techniques to evaluate deep geologic formations in Indiana County, Pennsylvania—Geologic structure from 2D seismic data

**MAPPING**

Completed three mapping projects under StateMap: 1) Bedrock map of Laporte quadrangle in Sullivan County in northeastern PA, including a 1,400-foot bore hole to tie down lower Mississippian and upper Devonian stratigraphy. In cooperation with USGS Water Science Center, investigated water flow in open boreholes, obtained water quality samples at horizons of interest; 2) Bedrock map of Mingoville quadrangle in central PA, including a 1,095-foot core hole in the Gatesburg Formation to examine facies transitions on the Cambrian shelf. The Gatesburg is also an important aquifer with notoriously poor outcrops; 3) Surficial geologic map of the East Troy and Ulster quadrangles in Bradford County in northeastern PA. This project included two electrical resistivity surveys across the valley of Sugar Creek to investigate thickness and character of the glacial deposits filling the buried valley. Other maps completed this year were the Middletown quadrangle in central PA and the Frenchville quadrangle in north-central PA (bedrock), and the Towanda quadrangle in Bradford County (surficial).

Two major reports were released. *Groundwater and Petroleum Resources of Sullivan County, Pennsylvania* outlines the geology, groundwater resources, and gas-industry resources in Sullivan County, and compiles results of pre-drill water samples to provide baseline information on the quantity and quality of groundwater before any impacts occur from natural gas drilling. It was co-authored by staff of the PA Department of Environmental Protection. *Geohydrologic and water-quality characterization of a fractured-bedrock test hole in an area of Marcellus shale gas development, Bradford County, Pennsylvania* presents the results of geohydrologic investigations on a 1,664-foot-deep core hole in Bradford County, including core description, water quality analyses, isotopic analyses of water and core samples, geophysical logs, and downhole video clips.
The South Dakota Geological Survey is a Program in the Division of Financial and Technical Assistance, Department of Environment and Natural Resources. Although the Geological Survey’s main office is located on the University of South Dakota campus in Vermillion, the Geological Survey is part of the executive branch of state government. The mission of the Geological Survey is to perform scientific investigations that are designed to generate information on South Dakota’s geologic and hydrologic resources. Fundamental aspects of those investigations are to include the collection, interpretation, and dissemination of geologic and hydrologic information leading to: 1) a better understanding of the geology and hydrology of South Dakota; 2) better and easier use of the information by government, industry, and the public for decisions related to resource development and protection; 3) greater economic development, and 4) a better quality of life for South Dakota’s citizens.

STAFF

In this year, a long-time employee in an office-support role retired and that position was converted into a geologist’s position. A new geologist was then hired to primarily help with the performance of investigations of ground water resources in glacial sediments.

GEOLOGIC MAPPING

Two new maps of surface geology at a scale of 1:24,000 were published for the Hermosa and Tilford 7.5-minute quadrangles in the Black Hills. The mapping provides critical information for land-use decisions and provides the foundation for derivative maps of aquifer vulnerability.

AQUIFER DELINEATION

The drilling resources of the Geological Survey were focused on: 1) gaining an understanding of glacial geology, glacial outwash aquifers, and bedrock type and elevation in McCook County; 2) redefining the extent and thickness of a glacial outwash aquifer primarily in southwestern Spink County and 3) redefining the extent and thickness of a glacial outwash aquifer primarily in Turner County. These projects resulted in the drilling of 11,139 feet in 86 test holes, the installation of 37 monitoring wells, and the collection and analysis of 85 ground-water samples for common inorganic parameters.

Some of the information generated was, and will be, used in the making of Aquifer Materials maps. These maps are being produced for the portion of South Dakota east of the Missouri River (the glaciated area of the state). This map series depicts the depth from land surface to the first mappable aquifer units. These maps are needed by the public and by the Department of Environment and Natural Resources regarding South Dakota’s General Water Pollution Control Permit for Concentrated Animal Feeding Operations. The information is also needed by county and municipal governments in support of other land-use decisions.

Information that was generated in the field was also used to support decisions by a regulatory agency regarding the appropriation of ground water for irrigation. Results of work by the Geological Survey allowed the majority of requests for irrigation permits to be granted from a particular aquifer even though the interpretation of the extent of the aquifer was significantly changed due to the recent work.

STATEWIDE GROUND WATER QUALITY MONITORING NETWORK

Sampling of approximately half of this network occurred in fiscal 2014. This network consists of 150 wells at 85 locations that allow collection of water from 26 aquifers. The purpose of the network is to examine ambient water quality and assess non-point-source pollution in many of the surficial aquifers across the state. An important difference between South Dakota’s Statewide Ground Water Quality Monitoring Network and others in the country is that South Dakota’s was designed and installed by the Geological Survey specifically for this purpose. The locations of wells in the network and their construction, including dedicated sampling equipment, ensure high quality information regarding some of the state’s aquifers that are most vulnerable to human activities at land surface. The network has historically been monitored for common inorganic constituents (including nitrogen compounds), pesticides, trace metals, volatile organic compounds, and radionuclides. Analyses in fiscal year 2014 were for only common inorganic constituents and pesticides. Analyses for this reduced list of constituents is anticipated to be the norm for upcoming years.

OIL AND GAS INITIATIVE

The purpose of the initiative is to promote the exploration and development of South Dakota’s oil and gas resources. The effort includes the compilation and dissemination of all relevant state-held information through online, searchable databases and interactive maps. The Geological Survey has the responsibility of creating and maintaining a database of oil and gas related information that will meet the needs of Geological Survey staff, regulatory agencies, and industry. The Geological Survey will produce additional reports, maps, and cross sections pertaining to South Dakota’s oil and gas resources.

A study was completed this year related to South Dakota’s potential to have sand resources that could be used as proppant in hydraulic fracturing applications or to have the raw material for making ceramic proppant. The report is titled Assessment South Dakota’s Sand and Alumina for Use as a Proppant and is available for free download on the Geological Survey Program’s website.

Work began on the cutting and photographing of cores relevant to oil and gas in South Dakota. Information generated through this work will be made available on the Geological Survey Program’s website in an effort to promote more exploration in South Dakota.
The mission of the Tennessee Geological Survey (TGS) is to encourage and promote the prudent development and conservation of Tennessee's geological, energy, and mineral resources by developing and maintaining databases, maps and technical services; providing accurate geologic hazard assessments; and disseminating geologic information through publications and educational outreach activities.

ADMINISTRATION

TGS is part of the Bureau of Environment in the Tennessee Department of Environment and Conservation. The state geologist reports directly to the department's deputy commissioner. The main office in Nashville covers Middle and West Tennessee and a regional office in Knoxville covers East Tennessee. Originally established in 1831, TGS serves as advisor to state agencies and federal and local organizations on matters relating to Tennessee geology. The survey's work includes geologic hazards research, public service and education programs, basic and applied research on geology and mineral resources, and publication of geologic information. The survey also maintains a well cuttings and core sample library. Survey staff includes six geologists and an accounting technician, with an annual budget of $721,700.

GEOLOGIC MAPPING AND MINERAL RESOURCES ASSESSMENT

TGS performs basic geologic mapping, and mineral resources identification, evaluation, and mapping. Geologic mapping is a primary function of the survey, and TGS is the only state agency that publishes and distributes geologic maps. TGS has been engaged in detailed geologic mapping and mineral resources assessment at the 7.5-minute quadrangle scale (1 inch=2,000 feet) since 1960. Geologic maps and mineral resources summaries are distributed through a maps and publications sales office in Nashville.

During FY 2013–14 TGS staff completed four new geologic maps in GIS format. The new maps are the Alamo Digital Geologic Map in Crockett and Gibson counties, by Vince Antonacci and Mike Hoyal, the Concord Digital Geologic Map in Blount, Knox, and Loudon counties, by Martin Kohl, Barry Miller, Glen Miller, and Robin Hale, the Lovell Digital Geologic Map in Anderson, Knox, and Loudon counties, by Peter Lemiszki, and the Milan Digital Geologic Map in Gibson County, by Vince Antonacci and Mike Hoyal. All are at the 1:24,000 scale. Tennessee continues to rank among the top states in the nation in percentage of quadrangles mapped at this scale, with publication or release of more than 64 percent (517) of the 804 quadrangles covering Tennessee.

The survey's mapping program continued to receive a boost during FY 2013–14 with the awarding of the state's 20th grant through the State Geologic Mapping Program Element, STATEMAP, of the National Geologic Mapping Program. A $68,004 grant was awarded to map the geology of the Bells, Denmark, 50 percent of the Elverton, and 50 percent of the Meadow, Tennessee 7.5' quadrangles in Blount, Haywood, Madison, Loudon, Morgan, and Roane counties. Staff geologists Dr. Peter Lemiszki and Barry Miller from the survey's Knoxville office were responsible for Elverton and Meadow. Vince Antonacci and Mike Hoyal from the survey's Nashville office were assigned to Bells and Denmark.

In addition, TGS continued to work under a $174,500 contract from the National Park Service (NPS) to complete geologic mapping of the Bells SW, Oneida North, and Sharp Place Tennessee 7.5' quadrangles in the Big South Fork National River and Recreation Area (BISO) in Scott County by September 30, 2015. The 1997 NPS Strategic plan prescribes a digital geologic map as one of twelve essential data sets for parks. To meet this goal, the Natural Resources Program Center has undertaken a Geologic Resource Inventory of 270 natural area parks. BISO is identified as one of those parks. This project is designed to accelerate completion of the BISO geologic map, and will follow the same process as identified in TGS's 2010 STATEMAP proposal for the adjacent Rugby quadrangle, which was given high priority by the TMAC at the request of the NPS. In addition to other issues, this project will address natural resource development and environmental impacts, including those associated with coal mining and oil and gas exploration. Coal data obtained during mapping of the area such as strip and underground mine extent, coal thickness and elevation, and exploratory drill hole information will be utilized and also entered into the NCRDS database. Staff geologist Albert Horton from the survey's Nashville office has been working on this project, and completed the Oneida North Geologic Map at the end of 2013.

PUBLICATIONS SALES

TGS maintains a maps and publications sales office that stocks over 1,450 individual items for resale, including maps, reports, and books from survey activities and outside sources. The survey reprinted 500 copies of Bulletin 64, Caves of Tennessee and 100 copies of Bulletin 72, Gold Deposits of the Coker Creek District, Monroe County, Tennessee during FY 2013–2014. A catalogue of publications is posted online, and printed copies are available upon request. Sales of more than $3,700 accounted for only slightly more than 0.55 percent of the survey's revenue during the fiscal year.

COOPERATIVE PROJECTS

Although federal funding through the U.S. Geological Survey's (USGS) National Coal Resources Data System ended during FY 2012–2013 staff geologist Barry Miller and secretary Becky Hawkins from the survey's Knoxville office continue to work intermittently on a project to revise Tennessee's coal reserve database. The Tennessee survey's goal is to complete the evaluation of coal reserves on a 7 1/2-minute quadrangle-by-quadrangle basis for each of the 125 maps covering the Tennessee coalfields. This will help in the search for new deposits of coal. Work continued on a series of bulletins on coal zone correlations in Tennessee. The Tennessee coalfields will be divided into three distinct
regions that include the Cumberland Block (also called the Pine Mountain Overthrust) area, the northern coalfields, and the southern coalfields. Each bulletin will concentrate on a specific area and include regional cross-sections, coal correlations, and coal type-sections in that region. The bulletins will include preferred coal zone nomenclature, equivalent nomenclature (local coal names), and regionally recognized marine and other key horizons. This work will help to better characterize and standardize the coal beds and their nomenclature.

TGS also worked under a $28,073.50 cooperative agreement for fiscal year 2013–2014 from the USGS under the National Geological and Geophysical Data Preservation Program (NNGDPP). In March of 2014 the survey completed a proposal for more than $18,000 for work to be completed during fiscal year 2014–2015. Since 2007, the survey has received more than $63,000 under this program. NNGDPP is a federal grant program designed to preserve state geological survey data collections and provide a means for potential users of that data to determine what is available. Common standards, procedures, and protocols for metadata have been established and the holdings of each collection will be accessible through an Internet-based catalog, the National Digital Catalog (NDC).

Two broad objectives under the fiscal year 2012–2013 cooperative agreement were to compile metadata in a format suitable for input into the National Digital Catalog (NDC) and to convert paper/mylar documents into a digital format. The first objective involved creating metadata records and digitally capturing 1,000 items in the Coal Exploration Core Hole Logs Collection. This objective was achieved with the compilation of 1,026 metadata records and the documents associated with these records converted to digital format scans for uploading into the NDC. The second objective was to digitally capture 1,000 documents in the Zinc Mining Maps and Reports Collection. This objective was achieved with the digital capture of 1,020 documents that included maps, cross sections, and drill logs. The metadata records were compiled in an Excel spreadsheet database for uploading into the NDC. Pete Lemiszki, Barry Miller, and Becky Hawkins contributed to this year’s project.

During fiscal year 2013–2014 TGS completed work under an $187,122 grant from the U.S. Department of Energy, part of a three-year project under the American Recovery and Reinvestment Act designed to populate a National Geothermal Data System with geothermal-relevant data from all 50 states. Led by the Arizona Geological Survey on behalf of the Association of American State Geologists, TGS partnered with 49 other state geological surveys to evaluate geothermal potential in the United States and to populate the data system with relevant Tennessee-specific geothermal data as an integral component in advancing geothermal technology and creating associated economic development opportunities. The Tennessee data include:

- Oil & Gas Bottom Hole Temperature Dataset and Scanned Well Logs (2,802 records);
- Bedrock Thermal Conductivity Geothermal Test Reports Dataset (97 records);
- Spring Temperature Dataset (1,121 records);
- Rock Core Dataset (100 records);
- Oil and Gas Well Cuttings Dataset (500 records);
- County Depth to Bedrock Maps Dataset (Dickson, Rutherford, Williamson) (3 records); and
- Digital 7.5 Minute Quadrangle Geologic Maps Dataset (100 records).

Since 1966 TGS has been operating a seismic station inside its core storage facility at Waverly, Tennessee. The station has three broadband sensors and a secondary broadband sensor. These sensors are recording on 20-bit channels of high resolution digitizers. There is also a strong-motion sensor that is recorded on three 24-bit digitizer channels. Designated as WVT, this station is part of a national seismic network designed to improve earthquake monitoring in the New Madrid Seismic Zone (NMSZ). It is operated under a cooperative agreement with the USGS National Earthquake Information Center and St. Louis University. The station has a satellite transmitter with digital processing unit, and is accessible by computer dial-up. Data are uplinked to Golden, Colorado. Because of its quiet location, which allows for better seismometer response in the low frequency range, and its proximity to the NMSZ, WVT is considered to be an important part of the Global Seismic Network.

**PUBLIC OUTREACH AND GEOLOGIC HAZARDS ASSISTANCE**

TGS maintains active public outreach by furnishing speakers on Tennessee geology, mineral resources, and geologic hazards to schools, civic groups, and other organizations. Survey personnel gave 11 lectures, led two field trips, and manned survey booths at the Knoxville Gem and Mineral Show, Roane State Community College GIS Day, and National Wild Turkey Federation convention during FY 2013–14, involving more than 5,000 individuals. TGS’s Nashville office also distributed 150 American Geological Institute Earth Science Week toolkits and secured a gubernatorial proclamation for Earth Science Week 2013.

Survey personnel respond to requests for field inspection of geologic hazards. Homeowners, builders, and investigators frequently call upon us for assistance in evaluating such geologic hazards as landslide potential, old and newly opened sinkholes, and the potential for ground water contamination. Prospective landowners often ask us to examine property for potential geologic hazards, and members of the public frequently bring in rock and mineral specimens for identification. Survey staff answered more than 400 geologic information requests, performed eight environmental evaluations, and conducted 27 geohazard inspections, involving two occurrences of foundation damage, one landslide, five subsidence problems, one instance of seemingly out-of-place rock, and 18 sinkholes during FY 2013–14. Knoxville office staff also performed geologic hazard evaluations for four East Tennessee Development District projects.

In addition, survey personnel occasionally become involved with independent research projects. Dr. Peter Lemiszki of the survey’s Knoxville office spent a day in Cherokee Caverns with Dr. Kathleen Affholter from Pellissippi State Community College in order to collect cave sediment samples for DNA analysis, and also co-authored a manuscript entitled Sensitivity of Injection Costs to Input Petrophysical Parameters in Numerical Geologic Carbon Sequestration Models that has been accepted for publication in the International Journal of Greenhouse Gas Control.
The Bureau of Economic Geology, part of the John A. and Katherine G. Jackson School of Geosciences at The University of Texas at Austin, functions as the State Geological Survey of Texas. The Bureau curates the largest volume of subsurface core and cuttings in the United States at three world-class centers located in Houston, Austin, and Midland and maintains a major well log library with nearly 1.5 million Texas well records on file.

The Bureau conducts basic and applied research related to energy and environmental issues. Its mission is to provide research and advice related to these issues and to perform State Geological Survey functions as requested by the Texas State Legislature. Outreach efforts involve the public, state agencies, federal agencies, private foundations, and various industries.

**ENERGY RESEARCH**

The Fossil Energy group conducts approximately two-thirds of current Bureau research, focusing primarily on oil and natural-gas energy resources. Fossil Energy includes 10 Industrial Associates programs for basic research, as well as numerous sponsored-research projects funded by the State of Texas, the U.S. Department of Energy (DOE), and individual companies or groups of companies.

Main areas of focus include salt tectonics, carbonate and clastic reservoir characterization, fracture characterization and prediction, multicomponent seismic applications, shale systems, nanotechnology, and geofluids. From outcrop studies to the evolving science of reservoir characterization, the Bureau is noted for its insight and innovation. With 40 to 50 percent of in-place reserves typically remaining in the ground at the time of oil field abandonment, this research has enduring economic and societal importance.

The Bureau has developed a world-class unconventional oil and gas program focused on increasing petroleum energy reserves, educating stakeholders on energy economics through the Center for Energy Economics, and managing the Advanced Energy Consortium, which conducts leading-edge research in subsurface applications of nanotechnology to enhance petroleum production.

**ENVIRONMENTAL RESEARCH**

The diverse Environmental group conducts a wide range of basic and applied research in groundwater resources, vadose-zone hydrology, coastal studies, near-surface geophysics, and geologic mapping. The Gulf Coast Carbon Center is one of the national leaders in the study of geological sequestration of carbon. The Bureau is also developing additional programs that relate energy and the environment, including how water resources intersect fossil energy exploration/production and electricity generation from power plants. The group investigates characteristics and processes of shallow Earth systems and the impacts of human activities on those systems. Many of the projects address the needs of state and federal agencies in Texas, although the group conducts research in other states and in Latin America, as well.

The Bureau owns and operates an advanced airborne laser terrain and bathymetric mapping system (lidar) and a ground-based mapping system, both of which provide unique opportunities for conducting research requiring information on the shape and structure of the Earth’s surface. The Bureau’s newest equipment also includes hyperspectral imaging capability. Each project is well supported by complementary hardware and advanced software for data analysis and modeling, and researchers routinely apply related technologies in GIS, GPS, and remote sensing to maintain the research-grade survey quality necessary for many Earth-science applications.

**STATEMAP PROGRAM**

Bureau geologic mapping activities involve the Texas STATEMAP program and a geologic mapping component of the STARR program. Recently completed work includes a new geologic map covering the Travis Peak quadrangle of Central Texas, which illustrates Cretaceous and Quaternary deposits and inactive limestone quarries. This map, the first of a series covering the corridor northwest of Austin along the Colorado River, provides basic geologic framework information that will be used for managing earth and water resources and for land-use planning. Current mapping for the Texas STATEMAP program complements ongoing studies of land and water resources and environmental concerns of the state. Mapping along the Texas Gulf Coast Corridor at the Mission Delta and northern Copano Bay area (Bayside and Mission Bay quadrangles) will address geologic framework needs for planning and management of land use, evaluating historical changes of coastal depositional environments, addressing erosion issues, permitting activities related to resource development, and educating the public.
Mapping to support the economic development of mineral resources in Texas focuses on two mineral resources: (1) rare earth elements (REE) and associated beryllium (Be), uranium (U), and fluorine (F) in West Texas (Gunsights Hills South quadrangle, Texas); and (2) industrial sand/hydraulic-fracturing sand in South-Central Texas (Lasca and Losoya quadrangles). Mapping in the North-Central Texas Transportation Corridor (Hood quadrangle) will address the need for an accurate geologic map data set for proper management of water and earth resources and responsible land use. The western part of this area has potential industrial sand/hydraulic-fracturing sand resources and lime/limestone aggregate resources.

SERVICE TO THE STATE OF TEXAS

The Bureau of Economic Geology has a long-standing working relationship with State agencies that request our expertise when studying many issues that affect Texas. For example, Project STARR is funded by the State to increase royalty income to the Permanent School Fund through working with operators of State land leases to (1) improve the efficiency of producing fields, (2) look at new venture studies where regional fairways for drilling exploration wells will be emphasized, and (3) work in conjunction with CO2 sequestration studies to promote profitable sequestration of CO2 in oil fields through CO2-enhanced oil recovery. In addition, Project STARR now includes research in geothermal energy, energy and environmental economics, mineral resources mapping, the water-energy nexus, and hazards mapping.

The Bureau Environmental group works closely with the Texas Commission on Environmental Quality (TCEQ) on issues related to water quality, groundwater/surface water interactions, and the feasibility of injecting concentrates from desalination plants into depleted oil or gas fields. State regulations require that operators drilling for oil and gas have a Railroad Commission of Texas (RRC)–approved plan for well design that includes use of surface casing and cement to protect fresh water; the TCEQ and RRC have, with technical support from the Bureau, developed a web-searchable database that provides oil and gas operators with an estimate of required casing for all oil and gas wells.

The Bureau also serves on the Texas Groundwater Protection Committee, which was created by the Texas Legislature to bridge the gap between State groundwater programs, improve coordination between member agencies, and work to protect groundwater as a vital resource.

The DOE and the Texas General Land Office (GLO) provide funds to identify possible CO2 plays and estimate capacity in the Miocene formations in Texas State waters, including evaluating regional containment and fault/seal leakage, selecting suitable sites, and conducting risk assessments.

Within the past year, researchers from the Bureau of Economic Geology have begun operating a new hybrid airborne lidar instrument capable of simultaneously mapping topography and bathymetry to depths of 10 m or more in favorable environments. The system also acquires high-resolution color and color-infrared imagery. This system, acquired through a grant from the GLO, has been used in multiple projects in Texas to aid coastal geologic mapping, determine beach and dune sediment budgets, and analyze bay shoreline change and storm susceptibility. The new instrument significantly upgrades the Bureau's capability to assess the susceptibility, determine the impact, and monitor recovery from multiple geologic hazards affecting diverse environments around the state. In addition to the GLO, other potential partner agencies include the Texas Department of Transportation, Texas Parks and Wildlife Department, TCEQ, and Texas Water Development Board.

ACCOLADES

The Bureau made its presence known at the 2013 GCAGS Convention on October 6–8 in New Orleans:

- Senior Research Scientist Michael Hudic received the 2012 A. I. Levorsen Memorial Award, recognizing the best paper presented, with particular emphasis on creative thinking toward new ideas in exploration. Hudec also received the 2012 GCAGS/GCSSEPM Thomas A. Philpott Excellence of Presentation Award for his paper Explanation for Differences in Deepwater Salt Tectonics between the North-Central and Northwestern Gulf of Mexico.

- Tucker Hentz received the 2013 GCAGS Distinguished Service Award, largely for his editorial contributions to the GCAGS Transactions and the newly created GCAGS Journal, but also for his many publications on Gulf Coast geology and for his generous volunteer service over the years.

- Others receiving awards at the convention were Robert Reed and Stephen Ruppel, who placed third in the Gordon I. Atwater Best Poster Award competition for Pore Morphology and Distribution in the Cretaceous Eagle Ford Shale, South Texas, USA.

October 2013 also saw Bureau director Scott W. Tinker accepting two national awards for his years of extraordinary service to the general public:

- On October 24, the American Institute of Professional Geologists President Ron Wallace presented Tinker with the John T. Galey, Sr., Memorial Public Service Award at its awards dinner in Broomfield, Colorado. The Galey Award is established to honor geologists who provide “geological expertise where it is needed by the public at large,” and who “have outstanding records of public service on the national, state, or local level well beyond their normal professional responsibilities.”

- AGI President and JSG Dean Sharon Mosh-er, on behalf of the American Geosciences Institute (AGI), presented Scott W. Tinker with its Outstanding Contribution to the Public Understanding of the Geosciences award. Photo courtesy of the American Geosciences Institute.
The Bureau took the spotlight at the awards ceremony of AAPG’s 2014 Annual Convention and Exhibition, held in Houston, by garnering three major honors:

- The Robert R. Berg Outstanding Research Award is the AAPG’s fifth highest award, given in recognition of a singular achievement in petroleum geoscience research. The Bureau’s Bob Loucks was honored with this distinction this year, in part “For his key research in characterizing pore systems in hydrocarbon-bearing sedimentary successions and his ability to enthusiastically communicate these findings to the geoscience community.”
- The Bureau’s Charlie Kerans earned the distinction of being selected for AAPG’s Grover E. Murray Memorial Distinguished Educator Award. This award is given in recognition of distinguished and outstanding contributions to geological education. A respected professor in the Jackson School of Geosciences, Charlie says, “I enjoy demonstrating to my students their wisdom in studying sedimentary geology, a field that offers fascinating subject matter and welcoming cohorts.”
- Bureau director Scott W. Tinker and Harry Lynch, co-producer/director of the global energy documentary film Switch, together received AAPG’s Geosciences in the Media Award. This award is presented in recognition of notable journalistic achievement in any medium that contributes to public understanding of geology, energy resources, or the technology of oil and gas exploration. The Switch Energy Project has reached millions of viewers around the world through the film, its online outreach, and its broad energy education efforts.

The Bureau’s Scott Hamlin and Robert Baumgartner were named recipients of the 2014 Charles J. Mankin Memorial Award by the Association of American State Geologists (AASG). The award recognizes the outstanding state geological survey publication, with an emphasis on surface or subsurface geologic mapping, compilations, and associated reports. The Bureau’s Report of Investigations No. 277—Wolfberry (Wolfcampian-Leonardian) Deep-Water Depositional Systems in the Midland Basin: Stratigraphy, Lithofacies, Reservoirs, and Source Rocks—has been among the Bureau’s best sellers since its publication in 2012.

Bureau researchers were prolific in 2013, with more than 100 peer-reviewed publications featured in renowned academic journals worldwide. A total of 45 Bureau first authors who accounted for 70 of these publications were honored at the Bureau’s Publication Awards Dinner. Taking top honors at the ceremony was Sergey Fomel, who earned the 2014 Tinker Family Bureau of Economic Geology Publication Award for his exemplary publication record in exploration geophysics, and his dedication to the development of the open-source software “Madagascar,” as demonstrated in the 2013 publication, “Seismic wave extrapolation using lowrank symbol approximation in geophysical prospecting.” Fomel, Alex Sun, and Changbing Yang had the greatest number of first-author papers in 2013, with four each. Bill Ambrose and Bob Loucks shared the distinction of being honored six years in a row, every year since the inception of the awards program.

EDUCATION AND OUTREACH

The Bureau educates a broad group of citizens — the general public, elected officials, government employees, scientists and engineers in industry, undergraduate and graduate students, and K–12 students and teachers. The Bureau’s funded programs include the Texas High School Coastal Monitoring Program, which engages students, teachers, and residents of the Gulf Coast in the study of their natural environment. The Bureau also participates in the DOE-funded STORE program as a regional outreach hub for educating the public on carbon sequestration issues.

GeoFORCE is a selective outreach program of the Jackson School of Geosciences, designed to encourage students from minority-serving high schools in rural South Texas and inner-city Houston to take on the challenges of a rigorous math and science curriculum, to pursue higher education in these fields, and to enter the high-tech workforce. Each summer, GeoFORCE takes more than 600 high school students on spectacular geologic field trips in Texas and throughout the United States. Taught by
The Utah Geological Survey (UGS) is a division of the Department of Natural Resources (DNR), and is a largely non-regulatory agency focused on providing information about Utah’s geologic environment, resources, and hazards to promote safe, beneficial, and wise use of the land. A policy-making board consists of six members knowledgeable in aspects of Utah’s geology, and one public-at-large appointment. Staff includes 80 FTEs, of which there are 52 geologists and specialists and 28 support staff. Funding for the UGS comes from state-appropriated general funds (about 33%); mineral lease royalties from oil, gas, and coal extraction on federal lands in the state (about 37%); and contracts and grants with local, state, and federal government agencies (about 30%). UGS’s work is divided among five scientific programs in addition to administration and editorial support. During the year, 45 UGS Publications were published, and staff also contributed to 52 other publications.

The UGS’s Crawford Award went to Tyler Knudsen, Paul Inkenbrandt, Bill Lund, Mike Lowe, and Steve Boman in recognition of their combined work on the outstanding geologic publication Investigation of Land Subsidence and Earth Fissures in Cedar Valley, Iron County, Utah (UGS Special Study 150). The Crawford Award is the UGS’s most prestigious award that recognizes outstanding achievement, accomplishments, or contributions by a UGS scientist(s) to the understanding of some aspect of Utah geology or earth science.

The UGS/Utah Geological Association’s Lehi Hintze Award—which recognizes outstanding contributions to the geology of Utah—went to Robert Q. “Bob” Oaks, professor emeritus at Utah State University Geology Department, for a lifetime devoted to serving students, researching the geology of northern Utah and southern Idaho, and using his seemingly endless wealth of knowledge to benefit communities in those areas.

The Energy and Minerals Program (E&MP) encourages prudent energy and mineral resource development through a variety of studies to inventory, characterize, and model the state’s deposits. These projects have been funded in part by the U.S. Department of Energy (DOE), the U.S. Bureau of Land Management (BLM), the U.S. Geological Survey (USGS), and the Research Partnership to Secure Energy for America (RPSEA). Many projects include industry, academic, or consulting partners. Project results help extractive industries, the general public, and other local, state, and federal agencies make decisions about managing and developing energy and mineral resources in Utah.

Some recent E&MP projects include:

- **a)** studying Utah’s potential shale oil and gas reservoirs,
- **b)** defining potential geologic reservoirs for sequestering greenhouse gases,
- **c)** compiling deep coal drill hole data for the National Coal Resource Data System,
- **d)** evaluating mineral resources on state lands,
- **e)** collecting and compiling new data on information on the state’s geothermal resources.
accompanying booklets; inventorying, digitally scanning, and
inventorying and digitally scanning geologic maps, plates, and
data preservation project. This year’s work consisted of

Working Group meetings to set priorities, review research results,

and worked to improve Utah’s wetland functional assessment
along the Wasatch Front and in Cache Valley,

Army Corps of Engineers to create 44 geologic-based flood maps
geologic hazard mapping along the Wasatch Front with the
promotes hazard reduction through information dissemination.

or areas subject to development; responds to geologic-hazard
emergencies, provides scientific advice to local governments; and

 responding to the December, 2013, fatal rockfall in Rockville, Utah, where two people died in their home. The UGS published the results of the emergency response investigation as UGS RI 270 http://geology.utah.gov/online/ri/ri-270.pdf.

The Geologic Information and Outreach Program (GI&OP) answers public inquiries; performs public, teacher, and media outreach; prepares translated publications for a nontechnical audience; manages the Natural Resources Map & Bookstore and the Utah Geological Survey Library, and maintains the UGS website http://geology.utah.gov and the bookstore website http://mapstore.utah.gov.

Education outreach this year included conducting four
teacher and student classes for 2nd, 4th, and 5th grades, creating
one more Rock, Mineral, and Fossil kit, working on a new
Fossil education kit, loaning out 249 education kits, providing
hands-on activities for 650 students during Earth Science Week,
and judging four science fairs.

The GI&OP continued work on two brochures—Utah Hot Springs and GeoSights in Utah. And continued to emphasize the
UGS’s online presence by creating interactive geologic guides for fossils, landscaping rocks, rock and minerals, and even a tour of
Salt Lake City’s building stones.

The GI&OP tracks UGS outreach statistics: this year
the UGS responded to 4,100 inquiries, the websites received
763,000 visitor sessions, and the Library assisted over 900
patrons. The Library contains more than 14,000 publications.
The Map & Bookstore's inventory includes UGS publications, other DNR divisions’ publications, USGS topographic maps and
publications, Utah Geological Association guidebooks, and other
related publications and maps.

The Geologic Mapping Program (GMP) produces printed and
digital GIS geologic maps at popular intermediate and detailed
scales. Program goals are to complete at least preliminary inter-
mediate-scale (1:62,500–1:100,000) GIS map coverage of Utah’s
30’x60’ quadrangles by 2018 and to map selected areas at more
detailed 1:24,000-scale as priorities dictate. Maps are multi-
purpose, and many include booklets that describe the bedrock and
Quaternary deposits, structure, geologic hazards, economic geol-
yogy, ground-water resources, and scenic geologic resources. The
GMP provides these maps to geologists, government officials,
industry, academia, and the general public to promote better
understanding of Utah’s geology, delineate resource potential,
detect and assess geologic hazards, and aid in land-management
decisions.

This year, in the 30’x 60’ quadrangle series, the GMP
completed another block of mapping on four ongoing, multi-year
projects: Tooele, Loa, Duchesne, and Salina 30’x60’ quadrangles.
We also signed an outside contract for completion of the Beaver
30’x60’ quadrangle. Seven quadrangles are in various stages of
review and editing in preparation for final publication.

This year, the GMP published ten 7.5-minute quadrangle
geologic maps, and open-filed two others. The maps are in rapid-
ly urbanizing parts of the greater Wasatch Front area of northern
Utah, growth areas of southwest Utah, an area with important
water resources that is now of much development interest, and
areas with valuable geologic resources
As part of our effort to make geologic maps more accessible to our users, we continue to post geo-referenced images of 7.5’ quadrangle maps to our interactive geologic map website. To speed up completion of geologic map GIS databases, the GMP also implemented a new program to support student class or senior GIS projects of various older maps. These GIS products will temporarily fill holes in our GIS databases pending future new mapping, and provide excellent training for students. This program was quite successful in year one and is likely to expand in future years. The keys to its success are clear method and format guidelines and detailed hands-on instruction from UGS GIS personnel to assure map databases meet our standards.

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As a Division in the Department of Environmental Conservation, the Vermont Geological Survey (VGS) is guided by the mission to protect human health and safety. The activities of the Survey are guided by statute that designates the State Geologist as the Director of the Division of Geology and Mineral Resources. The purpose of the Division is to: 1) Conduct surveys and research related to the geology, mineral resources and topography of the state; 2) Give aid and advice as may be possible relating to the development and working of rock or mineral deposits suitable for building, road making and economic or other purposes; 3) Provide information and education to government, industry, other institutions and organizations and to citizens regarding the geology, mineral resources and topography of the state; 4) Provide technical information and advice regarding the management of mineral resources on state-owned lands, and cooperate where possible by providing geologic expertise and advice to persons conducting regulatory programs for the state; 5) Provide geological services for the natural gas and oil resources board; 6) Maintain records of old and new information relating to the geology, mineral resources and topography of the state and make public new information resulting from research and field studies conducted by or for the division; and 7) Prepare and publish reports on the geology, mineral resources and topography of the state.

Most recently, the Survey has focused on groundwater, geology and health, geology and hazards, and resources needed to respond to change in the environment or land use. Groundwater in fractured bedrock, radioactivity and arsenic issues, landslide hazard mapping and monitoring, and geochemical landscape are topics of current studies.

In terms of operations, we are moving towards results-based accountability (RBA) and performance measures which measure our positive impacts and products developed for the State. The main question asked by RBA is how our work makes a positive difference for Vermont.

STATEMAP PROGRAM
STATEMAP is a valuable cooperative program for the Survey. Bedrock and surficial maps have been used to address such issues as radioactivity and arsenic in groundwater, groundwater recharge potential and to mitigate landslide hazards. The VGS seeks to involve communities at a grassroots level and address issues specific to town and state needs while maintaining the quadrangle mapping structure. The funds are leveraged through student interns who spend time in the field and later complete projects ranging from water chemistry to tectonics. Maps are posted on the VGS web site for easy access by Vermont communities.

The following maps, funded in part by the STATEMAP program, were released in 2014:

VG14-1: Kim, J., Gale, M., Chu, K., Cincotta, M. and Cuccio, L., 2014, Bedrock Geologic Map of the northern portion of the South Mountain Quadrangle, Addison County, Vermont


GEOLOGY, GROUNDWATER AND HEALTH
In 2014, the Vermont Geological Survey and our Norwich University partner submitted bedrock and surficial geologic maps of the South Mountain Quadrangle. These maps comprise the basic geologic framework for the Town of Bristol and will be integrated with well log data to assess the groundwater and gravel resources of the town. The results of this study will be presented to Bristol town officials and residents in 2015. A collaborative study with the Middlebury College Geology Dept. on the groundwater chemistry of the Bristol area, which involved testing for arsenic and radionuclides, was completed in May.

As part of the National Geothermal Data Program, the VGS partnered with SUNY Plattsburgh to obtain bottom hole temperature and temperature gradients for 16 deep (>500’) bedrock wells in Vermont. The partnership subsequently expanded beyond the geothermal project and temperature, conductivity, natural gamma, and borehole diameter data were collected. The data sets were used to identify lithologies and planar structures where groundwater entered a well, and to perform complex hydrogeologic analysis for wells. Logging-based hydrogeologic studies are continuing on public water supply wells in the towns of Berlin and Hinesburg.

In addition to detailed studies, the VGS pursued regional groundwater characterization and development of statewide datasets. In 2014, we presented a poster at NEGSA which summarized work completed over the past decade and proposed next steps: “A GIS-based approach to characterizing Vermont’s groundwater resources.” The Survey is continuing with development of regional datasets, including till geochemistry and an enhancement of the USGS water use study completed by Medalie and Horn in 2010.

HAZARDS
Landslide hazard mapping, first response to landslides, and monitoring of landslide and rockfall sites were major activities of the hazard program. Outreach efforts were directed towards regional planning commissions and implementation of landslide
mapping protocols developed by Clift and Springston (2012) for identifying areas sensitive to landslide hazards. Other activities included groundwater mapping projects and drought, seismic hazard mitigation and outreach to critical facilities managers in northwest Vermont, and the HAZUS software program.

**TILL CHEMISTRY/CHARACTERIZATION STUDY**
The UVM Field Naturalist Program, the USDA Forest Service Northern Research Station, the USDA Green Mountain National Forest (GMNF) and the VGS are cooperating to understand spatial patterns in calcium supply to aid the Forest Service in predicting forest productivity, assessing the impacts and recovery of forests from air pollution, and in evaluating potential impacts of harvesting and other land management activities on forest health and productivity.

In addition, the VGS extended sampling of glacial till north into the Montpelier One-degree sheet in order to develop baseline geochemical data for environmental issues related to groundwater and surface water.

**NATIONAL GEOLOGICAL AND GEOPHYSICAL DATA PRESERVATION PROGRAM**
Vermont completed its first year of participation in the National Geological and Geophysical Data Preservation Program (NGGDP), a federally-funded program within the US Geological Survey (USGS) for the preservation of geoscience materials and data. The project goal is to preserve the Vermont Geological Survey’s (VGS) unpublished maps, documents, samples, and data and make the data available to the public. During the first year, the VGS conducted an inventory of our geological data, maps, and samples, developed Collection level categories for the inventoried materials and entered metadata for the Collections into the NGGDP/ScienceBase database, entered metadata for individual items in the Collections, and developed a plan for the preservation and archiving of the inventoried materials.

**EDUCATION, OUTREACH, AND PRESENTATIONS**
Survey staff remains active in education outreach through school visits, field trips for towns and local officials and the web site. The web site and personal interactions are the mainstays of our public communications. Publication of reports and presentations at professional meetings such as the National Groundwater Association and the Northeast Geological Society of America are important venues for maintaining our geologic expertise and contributing to the science community. The successful intern program involves university students in our field mapping projects and they subsequently complete and present their senior research, providing detailed data which is used to analyze current environmental issues.

**STUDENT/INTERN PRESENTATIONS AT NEGSA IN 2014**
Cincotta, M., Cuccio, L., Kim, J., Romanowicz, E., Klepeis, K., and Norland, W., 2014, Fractured bedrock hydrogeology of a well field in the complexly deformed Connecticut Valley Trough of central Vermont: GSA Abstracts with Programs, NE Section (49th annual meeting), v. 46, #2, p. 49.

Cuccio, L., Cincotta, M., Kim, J., Romanowicz, E., Klepeis, K., and Norland, W., Hydrogeology of a fractured bedrock aquifer in strongly deformed and metamorphosed rocks of the Rowe-Hawley Belt, central Vermont: GSA Abstracts with Programs, NE Section (49th annual meeting), v. 46, #2, p. 49.

**MILESTONES**
Laurence R. Becker retires as Vermont State Geologist in December 2014. Larry began working at the State of Vermont in 1981 and served since 1995 as the 13th State Geologist, the first being Charles Adams in 1845. For the past 20 years Larry directed the activities of the Geology Division and Vermont’s Radioactive Waste Management program. Prior to 1995 he served as Technical Services Chief for the VGS and as a groundwater planner for DEC. He developed the aquifer mapping protocols for Vermont’s aquifer protection program and managed the mapping programs, stream geomorphology studies, and advised the legislature on mineral industry issues and groundwater.

Larry served on numerous committees including: Chair of Education Committee, Association of American State Geologists; Chair, NESEC State Geologists - Northeastern States Emergency Consortium (NESEC); Vermont State Hazard Mitigation Committee; VT State Nuclear Advisory Panel; and the Groundwater Coordinating Committee.

Larry worked hard to connect the Survey and geology to other government Divisions, Departments and Agencies and made a constant and creative effort to apply geology to address issues in Vermont. He has excelled as a mediator of issues and advocate for science. His management style created a great workplace for Survey staff. The Vermont Geological Survey and geologic community are thankful for his years of service and wish the best for Larry in his retirement.
The Division of Geology and Mineral Resources (DGMR) is one of seven divisions in the Department of Mines, Minerals and Energy, a Commonwealth of Virginia agency whose mission is “to enhance the development and conservation of Virginia’s energy and mineral resources in a safe and environmentally sound manner to support a more productive economy.” DGMR serves as Virginia’s geological survey; the other divisions deal with mine safety, mine reclamation, gas and oil reclamation and safety, energy programs, and administration. Located in Charlottesville, DGMR performs geological and mineral resource investigations aimed at reducing risk from geologic hazards and encouraging sustainable economic development through the wise use of mineral, land, water, and energy resources. Division staff includes ten full-time geoscientists, five hourly support staff, and several external contractors at state universities. In FY 2014, funding for DGMR came from state-appropriated recurring general funds (36%), federal grants (60%), and proceeds from publication sales (4%). This was the third consecutive fiscal year in which federal funding made up more than half of the Division’s budget. DGMR’s activities are organized in two sections, Economic Geology and Geologic Mapping.

**ECONOMIC GEOLOGY**

The Economic Geology Section focuses on mineral and energy resources. This year, DGMR wrapped up its participation in the National Geothermal Data System under a grant from the AASG/Arizona Geological Survey State Geothermal Data project (U.S. Department of Energy funding). The primary focus in FY 2014 was on collection and input of data for North Carolina. The geothermal team also produced derivative maps from the Virginia dataset, including a statewide heat flow map and temperature-depth slices for the Southwest Virginia Coalfield. The Economic Geology section also participated in reservoir characterization studies to determine the potential for carbon capture and storage in selected geologic targets in Virginia. In a project supported by the U.S. Department of Energy and the Southern States Energy Board, DGMR geoscientists are assisting in reservoir characterization of deep, unmineable coal seams in the Virginia portion of the Central Appalachian Basin. In conjunction with the Virginia Tech Center for Coal and Energy Research and Cardno MMA, a Bluefield-based consulting firm, the project team will perform an injection test of 20,000 tonnes of carbon dioxide into coal seams in the Pennsylvanian Pocahontas and Lee formations.

A two-year cooperative project with the USGS Eastern Energy team is focused on describing the importance of mineral production in the years leading up to and during the Civil War. Salt, saltpeter, lead, iron, coal and other minerals were strategic for both sides in the war. Fact sheets and web content are being written for each state that contributed minerals to the war effort. The project will highlight the continuing importance of minerals and mining to our society through history.

Under the National Geological and Geophysical Data Preservation Program, the division continued to catalogue and curate a large collection of rock and mineral specimens that was divested by the University of Virginia. The specimens have now become part of the permanent DGMR collection. DGMR’s Data Preservation team repaired several antique display cases that came with the collection and used them to install educational displays about important minerals then in our library, where they are available for public viewing.

The Division continues to contribute data to the National Coal Resources Data System (NCRDS). With a grant from USGS, DGMR provided coal thickness and elevation data for several coal seams in the Southwest Virginia Coalfield. NCRDS continues to be an important source of data for characterizing remaining coal resources in the U.S. The Economic Geology Section is also supporting our agency’s coal mine reclamation permitting and enforcement program with the compilation of watershed-specific geologic maps and narratives, which are incorporated into Cumulative Hydrologic Impact Assessments (CHIAs).

**GEOLOGIC MAPPING**

Geologic mapping in Virginia is carried out under the STATEMAP program, funded under the USGS National Cooperative Geologic Mapping Program with a 50%-50% state-federal match. Projects are prioritized pursuant to the Division’s long-range mapping plan and approved by the Geologic Mapping Advisory Committee, a panel composed of representatives from the mining industry, academia, the consulting community, and state and federal agencies. Two continuing mapping projects are underway: the Interstate 81 corridor and the greater Richmond Metropolitan Statistical Area (MSA). In the I-81 corridor, geologic maps were completed for the Glenvar, Pilot, Rileyville, Timberville, and Woodstock quadrangles. In the Richmond MSA, geologic maps were completed for the Perkinsville, Quinton, South Anna, and Yellow Tavern quadrangles. All maps were compiled in ArcGIS v.10 using the NCGMP09 geodatabase data model.

**GEOLOGIC HAZARDS**

DGMR completed a landslide hazard mapping project in Page County, Virginia with our first grant under the FEMA Hazard Mitigation Grant Program. Page County was selected as the pilot project because of its reasonable size, the presence of both Blue Ridge and Valley and Ridge slope deposits, and proximity to our staff and contractors. The project involved advanced terrain modeling and field work to characterize landslide risk to public facilities and critical infrastructure. One professor and several students at James Madison University contributed to the project under a subcontract.

DGMR also convened a karst data work group with representatives from the state Department of Environmental Quality, the Department of Conservation and Recreation, the USGS, the consulting community, and the Virginia Speleological Survey. The intent of the group is to share available karst-related digital data and develop a database for the cooperative recording of field observations.
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The Geology and Earth Resources Division, as Washington’s Geological Survey, is mandated by legislation to provide geologic data and services that benefit the people of Washington. Information about our products and services is available on the Division’s web page at http://www.dnr.wa.gov/geology

To carry out its responsibilities during the period of July 2013 to June 2014, the Division employed 25 full-time equivalent staff, consisting of 12 geologists, 9 other professionals, and 4 support staff. The Division’s office is located in the Natural Resources Building in Olympia, Washington, where there are an extensive geology library, mineral property files, and an oil/gas well log and sample archive for use by the public, government, and industry.

The Division has maintained a presence in geological hazards, environmental geology, geological mapping, earth resources, a library, and keeping data availability on the internet as a priority. Federal grants have allowed the Division to continue to have a presence in each of these areas. The focus of the Division is on maintaining our existing geological data at this time and making it available to the public.

GEOLOGIC HAZARDS

The Hazards group which is mostly grant supported works on landslide, earthquake volcano, and tsunami hazards. Tsunami work is generally restricted to workshops and public outreach and is supported by grants from the State’s Emergency Management Division. We completed evaluation of tsunami evacuation routes on the outer coast in the event of a Cascadia subduction earthquake event that affects slope stability and liquefaction of the routes. This study takes on even more meaning since the Japan-Tohoku earthquake and tsunami of 2011. We created a landslide forecast tool with the National Weather Service to help give early warning to emergency managers https://fortress.wa.gov/dnr/landslidewarning/, transportation departments, and the public. We continue to do landslide research and concentrate on compilation maps for the Washington State Geologic Information Portal http://www.dnr.wa.gov/geologyportal. Earthquake research is supported by grants doing ANSS site evaluations throughout Washington which has the second highest risk from earthquakes after California.

GEOLOGIC MAPPING

The state geologic map program continues to produce two 1:24,000 geologic maps per year. Recent mapping has focused on the trend of the fault zones near Seattle and the active faulting and glacial stratigraphy in the Hood Canal area. Long-range plans continue to focus on the densely populated Puget Sound lowlands, areas with important groundwater issues, and rapidly growing areas where land use planning using high-quality, large-scale geologic maps are especially beneficial.

ENVIRONMENTAL GEOLOGY

Puget Sound Restoration is a main focus of the Division’s environmental efforts and its mapping and databases are intended to assist in reducing sources of water pollution by understanding groundwater pathways in the Puget Sound and evaluating slope stability for issues such as bulk head removal and beach nourishment.

The Division is striving to update detailed geologic mapping of the Puget Lowland to generate a depiction of the unconfined aquifer, generate a contour map of bedrock depth, create an infiltration susceptibility map, and develop a three-dimensional hydrogeologic model of Quaternary deposits. These products will help prevent pollutants from reaching the groundwater and the Puget Sound resulting from a lack of understanding of geology and water pathways, and provide a basis for legal protection of sensitive areas, ensuring protection of groundwater and working aquatic lands.

We have also started a web site on hazardous minerals information regarding naturally occurring asbestos, mercury, arsenic, uranium and radon that can found at http://www.dnr.wa.gov/ResearchScience/Topics/GeologicHazardsMapping/Pages/hazardous_minerals.aspx

RESOURCE GEOLOGY

Resource evaluations are focused on aggregate mapping and the geothermal resources. Geothermal investigations have been part of a state geological survey effort led by Arizona Geological Survey and funded by Department of Energy. The objective of the project is to acquire, assess, preserve, and make accessible to the National Geothermal Data System all available data that is pertinent to geothermal resource development in Washington State. This includes acquisition of existing data as well as data that can be gathered within the three year time frame of the grant. For example, existing data includes geologic information, well logs from Division files, heat flow and temperature gradients, rock and water geochemistry, geophysical data that can be assembled and converted, where necessary, to an electronically accessible format. The information will enhance exploration and development of geothermal resources within Washington by furthering understanding of the State’s geothermal systems that will be easily accessible to the public through the online Washington Geologic Information Portal. The next phase of the geothermal resource evaluations is participate in a Department of Energy grant using play fairway analysis. We will focus on developing favorability maps for specific areas of Washington. Aggregate resource maps will be done for two counties this year.

MINERAL AND OIL AND GAS REGULATORY SECTION

There has been no drilling for oil and gas in Washington this past year. Activity in the surface mine reclamation program has made important contributions to reclaiming mines in Washington. One of the most significant steps in regulation of mines in Washington is the use of detailed air photo program that can provide high resolution rectified photos of each mine. New mines and expansions of older properties are in the process of being permitted throughout Washington. Increased activity in
wind energy has increased the demand for rock to build roads and pads in eastern Washington and therefore many new mines have been opened. The Buckhorn Mountain gold mine which is the only operating gold mine in the state has stopped their exploration program and the mine is scheduled for closure next year.

DATA SERVICES AND WASHINGTON GEOLOGICAL INFORMATION PORTAL

The Division has created an interactive geology site known as the Washington State Geological Information Portal is widely used and has proven to be an effective way of communication geology to professionals and the public. Entry to the Portal is at http://www.dnr.wa.gov/geologyportal

The Portal provides geologists and non-geologists a way to use GIS tools for analysis without knowing ARCGIS and allows for production of customized maps for geology, hazards (landslide, earthquake, volcano, and tsunami), geothermal resources, mineral resources, tsunami evacuation routes, abandoned coal mines, and subsurface data.

WEST VIRGINIA

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The West Virginia Geological and Economic Survey (WVGES) has a broad mandate 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. Established in 1897, WVGES is an executive state agency within the Department of Commerce.

The mission of the Survey is to make publicly available timely, responsive, and credible geoscience information to promote wise public policy; to create wealth and general prosperity; and to maintain a high level of environmental quality, economic opportunity, and quality of life for all West Virginians.

The Coal Program investigates the quantity, quality, utility, location, mining, and geologic history of coal and coal-bearing rocks in West Virginia, producing databases, maps, reports, and providing consultation. Activities include: 1) creating and maintaining the Geographic Information System-based coal maps for use by the West Virginia Department of Revenue in mineral land taxation and other users; 2) contributing to a national database of coal stratigraphic and quality information; 3) sampling coal and coal-bearing rocks to determine composition; and 4) investigating coal bed methane potential.

The Coal Bed Mapping Program produces numerous products depicting aspects of West Virginia’s coal beds in a GIS format. Finished products are updated periodically as new data are obtained and served to all interested parties through the Survey’s web site. The program is in the final stages of the initial mapping, with approximately 95% of the planned mapping areas completed. In addition, new acquired mine maps and data continues to be compiled and entered into appropriate data bases. Initial mapping of the entire State should be materially finished in FY 2015 or early FY2016.

In addition to producing coal resource maps, Coal Program geologists are involved in geologic mapping of areas of the State adjacent to the coal fields. Cooperative work with various state, national and international geoscientists continues in the diverse fields of paleobotany, geochronography, Appalachian Basin stratigraphy, coal and overburden geochemistry, and coal bed methane resources. The development of a planned paleobotanical research facility is developing slowly with a collection exceeding over 20,000 specimens. Full scale implementation of this facility will likely not occur prior to the completion of the State’s coal resource mapping.

A program to develop a Geographic Information System will result in a comprehensive, standardized, public domain, digital cartographic database to be shared and used by government, the public, and the business community. Implemented by the State GIS Coordinator, components of this program are: 1) a GIS-based inventory of coal; 2) an accurate inventory of subsurface mineral ownership; 3) the Reserve Coal Valuation Model; 4) the Statewide GIS Technical Support Center at WVU; and 5) digital conversion of topographic maps. A major grant from the National Telecommunications and Information and Administration, funded through the American Recovery and Reinvestment Act, aims to increase broadband access and adoption through better data collection and broadband planning.

The Oil and Gas Program compiles and distributes information on oil and gas resources in the state by maintaining a publicly-accessible database and interactive web-based mapping applications, conducting research, publishing maps and reports, consulting with the public and industry, and giving presentations. Available information includes the location of oil and gas wells and fields, pays/shows and production rates of wells, and subsurface geology.

Data-related accomplishments include: 1) scanning additional geophysical logs for a new scanned log total for the entire collection of nearly 25,000 wells and digitizing log suites for 200 of those wells, with placement of these digital products on the agency’s website for staff usage and public download; 2) continuing to input data from well plats and completion records into the Oracle-based database in support of research and information programs, with public access to the data provided via the agency’s website; 3) on-going scanning of well records, with emphasis this year on digital preservation of the oldest well records in our collections; 4) maintaining a public library of 153 cores, with samples from more than 4,500 wells; 5) developing interactive mapping applications/services covering all wells, various tight gas plays, and the Marcellus Shale; and 6) creating downloadable data and mapping files available on the agency website which summarize current permitting and drilling activity for the Devonian Marcellus Shale play. There is considerable public interest in our e-logs, and in sampling our cores and cuttings for analysis.

Research programs currently underway include 1) a study of the stratigraphic framework of the Marcellus Shale across the
state, with a volumetric resource assessment specifically for West Virginia; 2) a major 5-state cooperative program to characterize the Ordovician Utica Shale in the central portion of the Appalachian Basin; 3) participation in a regional Carbon Dioxide Sequestration program funded by the U.S. Department of Energy to characterize reservoirs that may be suitable for enhanced oil recovery (EOR) or enhanced gas recovery (EGR) via CO₂ floods; and 4) a RPSEA regional cooperative study to evaluate depleted reservoirs for their potential to store brine or water produced as a by-product of oil and gas drilling.

Through fieldwork, research, service, and outreach, the Geoscience Program provides information and expertise on geologic mapping, environmental geology, geochemistry, hydrology, and resource assessment. Key activities include: 1) producing geologic maps through field work for sale to the public in paper, PDF, or GIS format; 2) providing environmental geological expertise in categories including earthquakes, karst, landslides, and mine subsidence; 3) collecting data on the geochemistry of bedrock and sediments; 4) gathering and distributing information on issues relating to ground- and surface-water hydrology; and 5) conducting advanced research on methods of resource assessment.

For the STATEMAP program, three geologic quadrangle maps were completed and submitted to the USGS. Additional funding was obtained for geological mapping of three quadrangles in east-central and southern West Virginia; field work commenced in the spring of 2014. Bedrock geologic maps generated for a four-year mapping project sponsored by the National Park Service were delivered in the fall of 2013.

WVGES participated in a three-year project sponsored by the United States Department of Energy and the Association of American State Geologists to increase the publically available data on geothermal resources in all fifty states. At Project end in the fall of 2013, WVGES had provided web-accessible versions of temperature logs, Bottom Hole Temperature (BHT) data for nearly 4,000 wells, and data for the state’s thermal springs and their water chemistry. In addition, WVGES, working in conjunction with researchers from West Virginia University’s Department of Chemical Engineering, provided 375 measurements of thermal conductivity taken using well cuttings from deep oil and gas wells in the Survey’s reference collection.

The Information Services Program facilitates accumulation, documentation, and categorization of results and interpretations of agency mapping and research, and provides and maintains programming and geotechnical information support for agency staff. Within this program, the Survey: 1) produces high-quality, cost-effective publications and information products summarizing research and service activities; 2) provides editorial, cartographic, and production support for agency programs; 3) provides information technology support and development for agency programs, including an integrated computing and networking infrastructure, an integrated mineral resources database, and administrative systems; and 4) develops Internet-based mapping services for public access to applications identified above, plus Ordovician Trenton-Black River reservoirs, Geothermal energy in West Virginia, and Broadband Mapping.

The Wisconsin Geological and Natural History Survey (WGNHS) has the principal assignment among state agencies to survey Wisconsin’s geological, mineral, and soil resources and to coordinate topographic mapping. It also has a shared responsibility with other state agencies for water resources. WGNHS was created by the Wisconsin Legislature in 1897; earlier state surveys in Wisconsin date back to 1854.

In 2013, the staff of the WGNHS consisted of 11 geologists and hydrogeologists, 6 technical support staff, 5 administrative staff, 11 students, and 9 limited-term employees. They were involved in a variety of mapping, research, and educational projects in the areas of geology, hydrogeology, and mineral resources.

GEOLOGIC MAPPING

The WGNHS continues to study Paleozoic bedrock in the state. These studies involve mapping of the mostly buried bedrock surface at a scale of 1:100,000 and a detailed characterization of the three-dimensional geometry and structure of Paleozoic units.

A multi-county study of predominantly Silurian bedrock along the Lake Michigan shore is underway to develop a regional understanding of the south–north changes in the depositional environments and the resulting variations in textures and structures of the local bedrock. As part of this study, we continued our multi-year bedrock mapping of Manitowoc County.

In south-central Wisconsin, we also continued bedrock mapping of Columbia County. Our goal is to better constrain the complex Cambrian–Ordovician geology, understand its influence on groundwater flow and quality patterns, and identify potential resources of frac sand. This mapping effort will support a groundwater resources study currently being conducted in the county.

And in the Driftless Area of southwest Wisconsin, the WGNHS continued a six-year project mapping the surficial geology to characterize the nature and distribution of unconsolidated lithostratigraphic units, geomorphologic units, and distinct landforms. By the end of this project, we will have mapped three full counties and two partial counties in the Lower Wisconsin and Kickapoo River valleys at a scale of 1:100,000.

QUATERNARY GEOLOGY STUDIES

In conjunction with mapping efforts in the unglaciated Driftless Area, the WGNHS is conducting research to better understand the chronology of the most recent (Last Glacial Maximum) glaciation in Wisconsin, the late Cenozoic evolution.
of the upper Mississippi drainage basin, and the significance of upland gravel deposits in southwestern Wisconsin and surrounding states.

**CHRONOLOGY OF LATE WISCONSIN GLACIATIONS**

While the overall chronology of Late Wisconsin (Last Glacial Maximum) glaciations in the Midwest is understood, constructing a detailed high-resolution record for advance and retreat of ice from maximum positions has until now proven futile. This largely reflects a general scarcity of organic material for dating glacial events, and the systemic difficulty of interpreting radiocarbon ages in glacial depositional environments.

Over the past several years, the WGNHS has been applying high-resolution dating—both radiocarbon and optically stimulated luminescence (OSL)—of ice-proximal lake deposits (the 1999–2014 water years are nearly complete). The Survey continues to collect new geophysical logs from deep wells as they become available; such logs are an invaluable resource for understanding the subsurface geology and hydrogeology of the state. For example, these tools were used to quantify and understand the potentially harmful impacts of a multi-aquifer well to a trout stream in western Wisconsin. This allowed the WDNR and the well owner to reconstruct the well in such a manner that it would no longer adversely affect the trout stream. In another project, we are using distributed temperature sensing and heat as a tracer to characterize aquifer heterogeneity. In particular, these tools can identify areas where fractures intersect wells and where major inflow to water supply wells occurs. Such information helps water supply officials optimize well design and understand potential contaminant pathways in the subsurface.

As part of a national project funding exploration and development of new geothermal fields and research into advanced geothermal technologies, the U.S. Department of Energy awarded nearly $100,000 to Wisconsin to catalog the state’s potential for geothermal energy.

**LATE CENOZOIC EVOLUTION OF THE UPPER MISSISSIPPI DRAINAGE**

The ongoing mapping in the lower Wisconsin River valley has led WGNHS geologists to initiate research into the long-term (late Cenozoic) evolution of drainage in the upper Mississippi basin. A combination of coring, analysis of LIDAR data, and GIS analysis of well logs indicates that the lower Wisconsin River valley was carved in pre-Quaternary time by a river flowing east, in the opposite direction of the modern Wisconsin River. The direct implication is that the entire upper Mississippi drainage developed as the headwaters of the St. Lawrence drainage, and was rerouted to become part of the modern Mississippi drainage by Quaternary glaciations. Current research is evaluating the impact of such a reorganization of mid-continent drainage on North Atlantic Ocean circulation patterns.

**UPLAND GRAVELS IN THE UPPER MIDWEST**

Refining, and in some case developing a basic understanding of, the lithostratigraphic units in Wisconsin is an ongoing goal. A prime example of this is the Windrow Formation, a patchy chert-pebble conglomerate found in southwestern Wisconsin.

Age control for the Windrow Formation is notoriously poor (designated as “late Devonian to early Quaternary” in published literature). WGNHS geologists are applying detrital zircon geochronology to gain new insights into the provenance and age of deposition of these upland gravels. Initial data derived from the sand matrix of a gravel sample in southwesternmost Wisconsin indicates the sediment was derived from the North American Cordillera (Wyoming, Idaho, Montana) during the early Eocene.

**GEOLOGIC AND HYDROGEOLOGIC ANALYSES**

In 2013, the WGNHS, with cooperation from USGS and funding from the Capital Area Regional Planning Commission continued work on a new groundwater flow model for Dane County.

Over the past few years, with Wisconsin Department of Natural Resources (WDNR) support, the WGNHS has significantly upgraded its geophysical logging capabilities, including the ability to obtain oriented optical and acoustic images from the interior of wells and boreholes. The Survey continues to collect new geophysical logs from deep wells as they become available; such logs are an invaluable resource for understanding the subsurface geology and hydrogeology of the state. For example, these tools were used to quantify and understand the potentially harmful impacts of a multi-aquifer well to a trout stream in western Wisconsin. This allowed the WDNR and the well owner to reconstruct the well in such a manner that it would no longer adversely affect the trout stream. In another project, we are using distributed temperature sensing and heat as a tracer to characterize aquifer heterogeneity. In particular, these tools can identify areas where fractures intersect wells and where major inflow to water supply wells occurs. Such information helps water supply officials optimize well design and understand potential contaminant pathways in the subsurface.

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In cooperation with the U.S. Forest Service and USGS, the WGNHS is nearly finished with a 5-year study of the groundwater resources of the National Forest units in Wisconsin. This information is being used by the Forest Service to support long-term forest management.

**VIRUSES IN GROUNDWATER**

An important outgrowth of the WGNHS aquitard studies has been the discovery of human enteric viruses in deep groundwater in confined aquifers in southern Wisconsin. Although the pathway of virus transport to the groundwater is not yet clear, the confirmed presence of viable viruses at depth in a bedrock aquifer has important implications for human health, water supply, and water treatment. The Survey received a major Science to Achieve Results (STAR) Grant from the U.S. Environmental Protection Agency to investigate potential transport pathways and mechanisms from sewers to groundwater in the Madison area.

**IMPACT OF SAND MINES ON GROUNDWATER RESOURCES**

Wisconsin is the nation’s leading producer of frac sand for the oil and gas industry. The rapid expansion of industrial sand mines has placed a demand on the area’s groundwater resources. Chippewa County, in western Wisconsin, has a particularly high concentration of sand mines. Since 2012, the WGNHS and the USGS have been working on a five-year study that was contracted by the county to study their groundwater resources. A soil-water balance model and a groundwater flow model are being developed as part of the study.

**GROUNDWATER RECHARGE**

Groundwater recharge is critical to maintaining the supply of Wisconsin’s groundwater, but mapping and quantifying the areal distribution of recharge and estimating recharge rates can be difficult. In cooperation with the University of Wisconsin–Madison, the WGNHS has developed a computerized technique for rapidly delineating recharge rates for use in regional groundwater models. This method combines geographic information system (GIS) data with basic landscape data and rainfall-runoff modeling. The WGNHS has cooperated with the USGS in refining and improving the computer programming necessary to run the model, resulting in much more efficient model operation. This method has become a common tool for estimating recharge over large areas of Wisconsin and has been used in neighboring states as well.
Fluid Flow in Carbonate and Fractured Rocks

Fractured rocks underlie much of Wisconsin and form important aquifers beneath large parts of the state. Groundwater movement in such rocks can be unusually rapid, and the rocks usually have very low ability to attenuate contaminants. Consequently, fractured rocks are very vulnerable to groundwater contamination. Predicting and monitoring groundwater flow in fractured rocks is challenging because these aquifers tend to develop two-component flow systems: rapid flow through small, discrete fractures and slower flow, but significant storage, in the matrix blocks.

Over the past few years, the WGNHS has developed a program of research and public education on groundwater movement in fractured rocks and has provided assistance to various agencies facing fractured-rock problems. Examples of recent work include verification of capture zones for municipal wells at Sturgeon Bay, investigation of groundwater under carbonate ridges in La Crosse County, and development of groundwater models for carbonate-rock areas in southeast Wisconsin and in Dane County. The WGNHS has developed a program of research and public education on groundwater movement in fractured rocks and has provided assistance to various agencies facing carbonate-rock problems.

Karst features, including a variety of sinkholes, cavities, and solution openings, commonly occur in carbonate rock (limestone and dolomite). Environmental problems associated with karst features include rapid groundwater contamination, unpredictable groundwater flow, difficulty in groundwater monitoring, and unexpected failure or collapse of surface structures such as roads and foundations. In recent years, concern has increased about the hazards and effects of karst features in many parts of Wisconsin, but little published information has been available. Survey scientists have conducted geophysical surveys near some of these features to characterize their depth and extent. The results of those studies have been used by municipalities for planning purposes and selecting options for sinkhole remediation. The WGNHS will continue to refine these geophysical techniques to more effectively characterize karst across Wisconsin and to provide data and consultation on karst issues as requested by various units of government and the public.

Investigating the Properties of Aquitards

Aquitards, geologic units that transmit little water, are extremely important in protecting adjacent aquifers from contamination, but are typically poorly understood. The WGNHS continues to investigate deep bedrock and shallow un lithified aquitards in various areas of the state. During 2013 the Survey initiated research on the New Rome aquitard, a Quaternary silt unit present in parts of the central Wisconsin sand plain. Understanding the properties of this aquitard is important for water management in the irrigated region of the central sand plain.

Groundwater–Surface Water Interaction

The broad subject of groundwater–surface water interaction encompasses many management areas, including lake management, protection of springs, and impacts of groundwater withdrawals on surface water features. An important current project is a new groundwater flow model of the Little Plover River region in Wisconsin’s Central Sand Plains. Expanded groundwater use for crop irrigation has been blamed for current low stream flows and lake levels in the region, and the WDNR requested and funded development of a new flow model, in cooperation with the USGS, to improve understanding of the groundwater-surface water system and serve as a tool for investigating future management options.

Also in support of WDNR water management needs, the WGNHS is undertaking a new inventory of springs in Wisconsin.

Statewide Groundwater Level Monitoring Network

A statewide groundwater level monitoring network has been operated jointly with the USGS since 1946. Currently, the network consists of 134 wells and 2 spring gaging stations in 52 counties. The network provides a consistent, long-term record of fluctuations in water levels in deep and shallow aquifers. Such information is critical for accurate analyses of the effects of high capacity well pumping, the response of groundwater levels to droughts, and the effects of land-use changes on groundwater systems. The long-term data are also used for calibration of regional groundwater models. The WGNHS, in cooperation with the USGS, will continue to compile and interpret data from the statewide network and will make the data available on the USGS web site at http://wi.water.usgs.gov/data/groundwater.html. In addition, the WGNHS will continue to evaluate individual wells in the network, supply the information to public and private clients, and aid in data interpretation.

Compilation of Existing Statewide Hydrogeologic Information

During discussions and hearings about proposed water quantity legislation in late 2009 and early 2010, it became clear that there is a need to make hydrogeologic data about Wisconsin more readily available. With funding from the WDNR, the WGNHS is developing an online hydrologic data viewer that allows users to retrieve both basic data and reports from across the state in an interactive-map-based format. This tool is already in use by WDNR staff and eventually will be released for public use.

Investigation of Unsewered Rural Subdivisions

Population growth and urban expansion in many areas has resulted in residential development on formerly agricultural land, but there have been few studies of the impacts of such developments on groundwater quality. To document the effects of this land-use conversion on groundwater quality, the WGNHS began a monitoring program to collect water-quality data before, during, and after construction of a new, unsewered subdivision located on agricultural land several miles outside of Madison, Wisconsin. This project, in cooperation with the Dane County Executive and the Madison Builders Association, is one of the first scientifically rigorous studies of the before and after impacts of rural subdivisions in the United States, and has continued for over a decade.

Outreach and Education

The WGNHS has been active in a number of outreach and education activities. Since 2001, using funding from an EPA grant, the WGNHS has partnered with the WDNR and the Center for Watershed Science and Education to teach teachers how to integrate groundwater into their curriculum. Staff have also been on public radio, talking about topics ranging from caves and karst to meteorites to climate change and groundwater. In 2013, the Survey greatly expanded the amount of information on our web-
site (WisconsinGeologicalSurvey.org) and was an active presence on Facebook (facebook.com/wgnhs) and Twitter (twitter.com/wgnhs).

**DATA-PRESERVATION INITIATIVE**

In recent years, the WGNHS has made a major commitment to address the preservation and accessibility of its over 150 distinct data collections. These collections reflect more than 100 years of geologic (both glacial and bedrock), hydrogeologic, and soils-related research. This research has generated significant volumes of physical samples—rock core, sediment core, well cuttings, sediment samples, rock samples, and thin-sections—and includes supporting documentation, such as field books, and other paper documents, such as correspondence, maps, and published and unpublished reports.

In addition to the continuing development of the Mount Horeb Research Collections and Education Center, which houses the Survey’s extensive physical collections, WGNHS has participated in the National Geologic and Geochemical Data Preservation Program (NGGDPP), developing a long-term data preservation plan and initiating the conversion of the information regarding its collections into National Digital Catalog-compliant metadata. As part of the NGGDPP for 2013, we continued inventorying and assessing a body of work that had been conducted on the Lake Superior region’s Precambrian rocks from the late 1800s to the early 1900s. This collection consists of 450 field notebooks, 10,000 thin sections, and 7,000 rock samples.
THE 2014 DISTINGUISHED SERVICE AWARD

This year's recipient of the AASG Distinguished Service Award is Dr. Peter Scholle, who served as state geologist of New Mexico from 1999 to 2011.

Most of you here know Peter quite well. Peter came to the New Mexico Bureau of Geology in 1999. Already a distinguished and well-known scientist, Peter brought with him an enormous-ly diverse background, a collegial spirit, and a quick mind. [And a quick wit, I might add…] His broad experience included the arenas of academia, industry, government, and research. It was this experience that gave Peter the unique perspective he had, and which I believe allowed him to excel both as a director and as a member of AASG. Peter quickly recognized the importance of this organization, to our efforts in New Mexico, and to the broader efforts of the state geological survey world. By 2002 he was already serving as treasurer of the organization, and by 2005 he was president of AASG. Very early on in his time at the bureau, he made a point of involving other members of our staff, including myself, in the affairs of the organization, and encouraged our participation not only in annual meetings but in liaison meetings and associates activities. During Peter’s tenure as president, in 2006, he hosted the annual meeting in Santa Fe, the first time New Mexico had hosted an annual meeting in 50 years. Since his retirement in 2011, Peter continues to serve on the board of the AASG Foundation.

In the course of Peter’s career, he has been involved in many organizations, often in roles of leadership. But I know that this recognition, from an organization to which he was deeply committed, means as much or more to him than any of them. Peter believed in mentoring, in the broader societal impacts of all that we do, and in the importance of the Earth Sciences to our future as a country. I was proud to have him as our director, and I am honored to have been asked to present this award.

—L. Greer Price
Director and State Geologist
New Mexico Bureau of Geology and Mineral Resources

Scholle Acceptance—It is a great honor indeed to receive this award from the AASG, an organization that has meant more to me than any other. The AASG is the most collegial and supportive group of dedicated people that I have had the pleasure to know, and any work I did with AASG has been a pleasure rather than as service. I think that part of the reason that AASG is such a fine organization is that it is composed of people of remarkable knowledge and integrity who are primarily devoted to public service rather than to personal gain, itself a rarity in today's world. But it is also a small organization of people who share common problems without really competing with each other very often. I know that the mentoring I received and the specific advice I got from other AASG members (and that I hope I was able to pass on to others, in turn) made a huge difference in my ability to do my job as a state geologist.

AASG is a staffless organization that shares its workload more equally than any other society I know. From running the Liaison and annual meetings, to keeping the books or staffing panels and committees, it is a remarkably diverse and egalitarian group. Thus, from year to year, the work may be done by different people, but it is always done well and with cheer and efficiency. In part, that reflects the fact that each AASG member is the head of an organization. So much of the work that is recognized in this award each year reflects the support we get from the staff of our home surveys, and that is certainly true in my case. Almost every member of the New Mexico Bureau of Geology & Mineral Resources played some role in the Annual Meeting we hosted in 2006 and many have helped with Liaison meetings or other tasks.

And that makes it especially hard for me to be singled out for this award. I accept it with gratitude, and thank you for it, but I do so with the knowledge that what I did for the organization was neither unusual nor exceptional, and it certainly was not done alone. I hope you will consider this an award to the organization itself and to all of us that constitute it—that way it will be an award in the true spirit of AASG.

CHARLES J. MANKIN MEMORIAL AWARD 2014

It gives me great pleasure today to present the Mankin Award, in memory of our colleague Charlie Mankin, who did so much to advance the objectives of the AASG community.

Our good friend and deeply respected colleague Charlie Mankin earned a Ph.D. from the University of Texas in 1958, he joined University of Oklahoma in 1959, and from 1967 to 2007 he was Director of the Oklahoma Geological Survey. He was AASG President in 1975–76, AGI President in 1978-79, and Campbell Medalist in 1987. Charlie played a key role in establishing STATEMAP, a program crucial to the state geological survey world. By 2002 he was already serving as treasurer of the organization, and by 2005 he was president of AASG. Very early on in his time at the bureau, he made a point of involving other members of our staff, including myself, in the affairs of the organization, and encouraged our participation not only in annual meetings but in liaison meetings and associates activities. During Peter’s tenure as president, in 2006, he hosted the annual meeting in Santa Fe, the first time New Mexico had hosted an annual meeting in 50 years. Since his retirement in 2011, Peter continues to serve on the board of the AASG Foundation.

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—L. Greer Price
Director and State Geologist
New Mexico Bureau of Geology and Mineral Resources

The Award will therefore now be given each year to a nominated geological map, compilation, or report on regional, energy, or mineral resource geology published in one of the three preceding calendar years by a state geological survey.

Our call for nominations again resulted in an incredibly impressive set of highly worthy nominations that presented a great challenge for the selection.

The selection committee assessed uniqueness, significance as a model, and overall worthiness, with quantitative scoring on each of 1) nomination & letters, 2) project design, 3) quality of the science, 4) relevance to scientific & societal issues, 5) quality of the presentation, and 6) likely impact.

Although all nominated publications were superb, one
clearly stood out as being extraordinarily deserving.


Congratulations to the authors who are joining us today by Skype; we are pleased that Scott Tinker is here in person to receive the award on behalf of the co-authors.

—Harvey Thorliefson

JOHN C. FRYE MEMORIAL AWARD 2014

Environmental geology has steadily risen in prominence over recent decades, and to support the growth of this important field, the John C. Frye Memorial Award was established in 1989 by GSA and AASG.

John C. Frye joined USGS in 1938, he went to the Kansas Geological Survey in 1942, he was its Director from 1945 to 1954, he was Chief of the Illinois State Geological Survey until 1974, and he was GSA Executive Director until his retirement in 1982, shortly before his death. John was also active in AASG and on national committees, and was influential in the growth of environmental geology.

The John C. Frye Memorial Award is given each year to a nominated environmental geology publication released in one of the three preceding calendar years, either by GSA or by a state geological survey.

ASSOCIATION OF AMERICAN STATE GEOLOGISTS

PICK & GAVEL AWARD

The Association of American State Geologists has selected to present this year’s Pick & Gavel Award to the Honorable Kenneth S. Calvert, United States Congressman from the 42nd District of California.

The Pick and Gavel Award was conceived in 1999 to honor distinguished friends of geology who have made major contributions in advancing or facilitating the role that the geosciences play in our society. In particular, the AASG recognizes the Congressman’s role in promoting sound science in public policy decisions, his leadership in protecting the nation’s forests through enlightened management, in wildfire prevention, and in encouraging the development of the nation’s energy resources. The AASG is proud to have Congressman Kenneth S. Calvert as its 2014 honoree. Congressman Calvert is the 25th individual to receive this national recognition.

Representative Calvert is a lifelong resident of Riverside County, California. Schooled locally, he received his Bachelor of Arts degree in Economics from San Diego State University in 1975.

In 1992 Ken Calvert was elected to the 103rd Congress, where he served as an active Member of the Resources Committee and the Science Committee. He subsequently became the Chairman of the Energy and Mineral Subcommittee. While unusual for a sophomore Member to be given a Chairmanship after only one term in Congress, Ken Calvert also served on two other Committees: maintaining his seat on the Science Committee and gaining a seat on the Agriculture Committee. Over the years his committee assignments enabled him to address issues critical to the nation such as the Endangered Species Act, agriculture, energy, and water. Representative Calvert was Chairman of the Science Subcommittee on Energy and the Environment where he worked on alternative energy and clean air issues.

While on the Resources Committee, he became Chairman of the Water and Power Subcommittee overseeing Federal water rights in the West, including hydro-power generated from Federal water projects. As Chairman, he introduced and helped pass the Water Supply, Reliability, and Environmental Improvement Act, which reauthorized the massive CALFED Bay-Delta Program in California.

Representative Calvert has also served as the Ranking Member of the House Science Subcommittee on Space and Aeronautics, in addition to being on the Energy and Water
Subcommittee and the Interior and Environment Subcommittee. The Congressman has given additional service as the Ranking Member of the House Select Intelligence Oversight Panel of the House Committee on Appropriations.

Today, Congressman Calvert continues to serve as a member of the Defense Subcommittee and the Energy and Water Subcommittee, on the House Budget Committee, and was recently selected to be Chairman of the House Appropriations Subcommittee on Interior, Environment, and Related Agencies. This Subcommittee has jurisdiction over the Environmental Protection Agency, the Department of the Interior, and the U.S. Forest Service. Currently, the Congressman is focusing his attention on wildfire prevention and management, as well as on loosening the restrictions on energy developments.

It is with the greatest pleasure and honor that the Association of American State Geologists presents this year’s Pick and Gavel Award to the Honorable Kenneth S. Calvert from California.

—John G. Parrish
President, AASG
California State Geologist

2014 AGI MEDAL IN MEMORY OF IAN CAMPBELL

Dr. James F. Davis has demonstrated an exemplary career as a professional geologist in public service for 50 years.

Dr. Davis commenced his long service career as an Associate Scientist at the New York State Geological Survey in 1963. Five years later, he was appointed State Geologist of New York, a position he held successfully for the next decade (1968 – 1978). While in this position, Jim demonstrated the importance of geology and seismology as critical fields in the siting of nuclear power plants and associated waste disposal facilities.

In 1978, Jim resigned his position in New York to become the 19th California State Geologist, following a tradition that began in 1850 with the first State Geologist, John Boardman Trask. Jim proved to be the longest serving California State Geologist, with 23 years (1978 – 2003) of creative and honorable service. Under Jim’s determined leadership, the then California Division of Mines and Geology greatly expanded its scope of programs from the traditional mining and mineral resources, and regional geologic mapping, into the ever widening and complex fields of geological hazards, earthquake engineering and strong motion seismology, and quantitative seismic hazards assessments. During Jim’s tenure he oversaw the passage and implementation of the Seismic Hazards Mapping Act (1990), which today has mapped liquefaction and landslide hazards covering 119 7½-Minute Quadrangles (7,400 square miles) affecting over 150 communities.

Jim has been a strong advocate for modern seismic monitoring systems as a tool for locating earthquakes and measuring their size, and for acquiring ground motion data for use by structural engineers to make structures more earthquake resilient. In 1971 the California Legislature adopted the Strong Motion Instrumentation Program (SMIP) to monitor the effects of earthquake strong motion on structures. The information gathered by this program directly affects the California Building Code. Under Jim’s guidance, the SMIP became the largest strong motion monitoring network in the United States, today with over 1,200 stations and 8,500 instruments in place. In addition, the CGS/SMIP is now an integral part of the California Integrated Seismic Network (CISN), a seismic monitoring network composed of many smaller networks operated by the U. S. Geological Survey, U. C. Berkeley Seismological Lab, Caltech, and others. Somewhere in Jim’s busy schedule, he found time to be the Chair or President of nine geological organizations, including President of the Association of American State Geologists (1985) and President of the American Geosciences Institute (1987). He, also, has been awarded five Lifetime Achievement and Distinguished Service awards.

For 11 years I had the pleasure of working directly with Jim in my capacity as Executive Officer of the California State Mining and Geology Board, which is the policy making body for the California Geological Survey. I developed a deep respect for Jim’s scientific acumen, as well as his political awareness and abilities to make things happen.

Today, Jim is anything but retired, continuing to be immersed in geology and its impacts on society – Jim just termed-out as an elected member of GSA’s Geology and Public Policy Committee, where typical to his character, he was busily reframing and making more relevant and understandable public policy decisions involving geological matters at local, state and national levels. As the direct successor to Dr. Davis’ survey, I personally can attest to the monuments that he created during his tenure at CGS, both statewide and nationally. It is particularly fitting that Jim Davis, a long-time friend of Ian Campbell whose career also greatly shaped the California Geological Survey, should receive this valued award named after his old friend.

As a very young staff member of the New York State Geological Survey I became acquainted with Ian Campbell when the New York Survey hosted the annual meeting of the Association of American State Geologists in 1962, during my second year of employment. In succeeding years, particularly after I became the New York State Geologist, I had opportunities to serve with Ian on many committees and directly witness his wise judgment and capable leadership.

Davis Acceptance— As a very young staff member of the New York State Geological Survey I became acquainted with Ian Campbell when the New York Survey hosted the annual meeting of the Association of American State Geologists in 1962, during my second year of employment. In succeeding years, particularly after I became the New York State Geologist, I had opportunities to serve with Ian on many committees and directly witness his wise judgment and capable leadership.

I want to share some of my thoughts about the benefits to society that result when professional earth scientists voluntarily use their time to share geoscience insights with the lay policy makers. When these insights result in the policies achieving their intended outcomes, society in general benefits. During my career I have had the opportunity to see the public policy value of using my time in this pursuit. I encourage all of my colleagues “to be a voice for geosciences in public policy” as stated in the 2013-17 version of Strategic Plan of the Geological Society of America.
During the early and mid-1970s America experienced what I call the “environmental sensitivity awakening” in which the public came to expect that federal, state and local governments would implement policies to reduce environmental abuses. This result was achieved in part by applying geoscience insights in the government environmental management policies in order to create higher quality outcomes. Because of their constitutional role of assuring the health and safety of their citizens, the state governments played a big role this transition. Today, the use of geoscience insights in developing effective ordinances and regulations at all governmental levels to preserve the quality of the environment, is much more extensive than it was before the “awakening”. The result has been the transformation from the concept of potentially using geologic insights in environmental management to todays’ reality. This reality encompasses land-use planning and development, waste disposal of all kinds, preservation of unique geologic areas and a host of other practices. Yes, a lot remains to be done, but the use of geoscience insights are critical to the environment as we gain additional experience and accomplish further progress in this important area.

I am honored to accept the 2014 Ian Campbell Medal on behalf of myself and the staff geologists who served with me in both New York and California.
MORRIS “BRUD” WELLMAN LEIGHTON
1926–2014

Morris W. Leighton passed away on Friday, April 11, 2014, surrounded by his family in his home in Urbana, Illinois. From a young age Morris, the middle of three boys, was known as “Brud”, short for a sibling’s “brudder.” The name stuck. Henceforth, to all he was Brud.

Brud was born in Urbana on June 17, 1926, the son of Morris M. and Ada Leighton. Just two years earlier, the senior Leighton, Brud’s dad, had been named the 6th State Geologist of Illinois and Chief of the Illinois State Geological Survey, titles that he held for 30 years.

Brud grew up in Urbana and graduated in the Urbana High School class of 1944 as Salutatorian. He continued his education at the University of Illinois, earning a B.S. in Chemistry in 1947. That fall he enrolled in the University of Chicago, completing his Masters and Ph.D. degrees in geology in 1948 and 1951.

Brud began his career with Standard Oil of New Jersey/Esso in Tulsa, where he had a distinguished career as geologist and manager. His scientific contributions over 32 years were extraordinary and sustained. He was instrumental in starting early work for Esso on sedimentary basins that later became known as basin analysis.

The oil business took Brud around the world with his high-school sweetheart and loving wife Jean and three daughters. Life was rigorous. In one stretch of 19 years they moved 18 times. But, the family thrived.

Upon retirement from Esso in 1983, Brud began a second career at the Illinois State Geological Survey as its Chief and as 10th State Geologist. When Brud retired from the ISGS in 1994, the Leighton family had run the Survey for 41 years, father (Morris M.) from 1924 to 1954 and son Brud (Morris W.) from 1983 to 1994. Together father and son had sustained transition of the “family business” into a modern geological survey and nurtured its growth into one of the largest in the nation.

Brud remained active with and supportive of the Geological Survey, the University of Illinois, the Department of Geology, the GSA, the AAPG, and the AASG. His involvement went beyond serving as an officer; his leadership and contributions helped move AASG, GSA and their missions forward. He was honored by all of the above and the State of Illinois and the University of Illinois for his professional activities in support of geology.


Brud was as a detail man. His preparations for presentations, meetings, legislative testimony, and the like are legendary. Brud’s handouts always employed the smallest possible font and narrowest of margins in order to include all “vitaly important” information.

Brud’s communication of priorities to his junior managers was clear. We remember daily marching orders that were hand written on yellow legal pads. We imagined these being prepared late at night. They were hand-delivered as the workday began. Each such “midnight missile” was coded with one, two, three, four, or five red stars at the top of the page. Lord help you if you were “blessed” with a 5-star.

Brud enjoyed retirement. He travelled extensively, including several times to Australia to be with his oldest daughter. He was an active “Ornery” and brought his daughters and grandchildren regularly to our annual meetings and field trips.

Brud was preceded in death by Jean and brother, Beach Leighton. He is survived by brother Richard Leighton; three daughters, Randi, Kathy, and Kari; and four grandchildren, Mike, Steve, Kami, and Rachel.

An outstanding leader, a powerful intellect, a man full of energy, gentleness, and integrity, with an endless capacity for the pun, Brud Leighton was, as Genevieve Attwood put it, “a brud to all of us.” He is sorely missed.

—E. D. McKay III, 12th State Geologist of Illinois, Emeritus
June 11, 2014

WALTER SCHMIDT

Dr. Walt Schmidt, retired Director of the Florida Geological Survey, and the state’s fifth State Geologist since 1907, passed away peacefully on March 29, 2014. Walt was born in Philadelphia and moved to Melbourne, Florida to attend Florida Institute of Technology where he met his devoted wife of forty-one years, Cheryl. He earned his Bachelor’s Degree at the University of South Florida and both a Master’s and Ph.D. in Geology at Florida State University. He retired from the FGS after 34 years of dedicated service.

Throughout Walt’s distinguished professional career he was active in many organizations including the Geological Society of America, American Institute of Professional Geologists, Florida Academy of Sciences, Ground Water Protection Council, and the American Geosciences Institute. Walt was a founding member of the Florida Association of Professional Geologists and served on the Florida Board of Professional Geologists, where he holds Florida PG license #1. He served as president of the Southeastern Geological Society and the Association of American State Geologists (AASG). During his tenure with the AASG, Walt was instrumental in supporting the passage of the 1992 National Cooperative Geologic Mapping Act and in 1996, he gave testimony in support of reauthorization of the Act before a US House of Representatives Subcommittee on Energy and Mineral Resources.

Walt’s professional dedication is exemplified by his service on numerous advisory and technical committees including the Florida Sinkhole Research Institute, Florida Geographic Information Advisory Council, Florida Governor’s Outer

IN MEMORIUM 2014

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Kentucky lost a great leader, educator, and advocate for Kentucky’s mineral and geological resources when Donald C. Haney died on June 8, 2014. He was state geologist and director of the Kentucky Geological Survey at UK from 1978 to 1999, where he oversaw tremendous growth in the Survey. He served on many state and national science and mineral resources committees, one of which was the Board on Earth Sciences and Resources for the National Research Council.

A most notable accomplishment was as one of the principal authors of the National Geologic Mapping Act, passed by the 102nd Congress in 1992. The purpose of the act was to expedite the production of geologic maps for all 50 states and for those maps to be applied to land-use management, conservation of natural resources, and protection of groundwater and the environment. For this great achievement he was honored with the William Lyons Award for distinguished public service from UK’s Martin School of Public Policy and Administration and the Ian Campbell Medal by the Geological Society of America and American Geosciences Institute.

Don’s tenure as state geologist was marked by great progress in coal assessment, groundwater research, mine subsidence programs, earthquake monitoring, and the construction of computer databases to serve the public. He also sought legislation to create the Kentucky Groundwater Monitoring Network and Groundwater Data Repository, also passed by the General Assembly. The organization of geologic data and records that he oversaw now serves millions of online requests for vital information about Kentucky’s resources and geology each year.

In the 1980s he saw the need for new offices for the Survey, so working with UK, industry, and public officials, he undertook construction of the Mining and Mineral Resources Building at UK. Later, growth of the UK campus required a new building for storing cores and rock samples, so the Kentucky Well Sample and Core Library was opened on Iron Works Pike in 1997.

Don achieved the highest levels in his profession, serving as president of the Association of American State Geologists and president of the American Geological Institute. After retirement, he was appointed to the Kentucky River Authority by Gov. Paul Patton.

Don was instrumental in passing legislation establishing the Kentucky Board of Registration for Professional Geologists and served as a board member.

From 1953 to 56, he was an intelligence specialist serving in the U.S. Army in the Philippines.

It is impossible to capture in these few words the profound impact of his accomplishments on Kentucky, but every map, publication, and online database that he made possible result in better decisions and wiser use of our land and resources, which will continue forever.

All the honors, awards, and accomplishments that Don Haney achieved do not tell the story of his warm, friendly, outgoing personality and his love of people and politics. Don never met a stranger; he spoke to everyone and loved to tell stories and joke with people. He was born and raised in Ferguson, Ky., and received B.S. and M.S. degrees from UK and a Ph.D. from the University of Tennessee. He loved Kentucky basketball and sat in his seat one row from the top of Rupp Arena for every home game.

At meetings and conferences, Don would make a point of greeting one and all. He was a great follower of politics and knew personally Kentucky’s political leadership in Frankfort and Washington, D.C., spanning six decades, and they knew and respected him. In Frankfort he was known to many as “Doc,” and could be seen carrying geologic maps, which he distributed freely. He was the founder and first chairman of the Geology Department at Eastern Kentucky University. That department achieved great distinction in the 1970s, and students he mentored went on to careers as state geologists in seven states; scores of other students went into academia and industry. This is a remarkable legacy.

He was preceded in death by his son Greg and is survived by his wife Shirley, daughter Holly, and granddaughter Bristol.