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A 1922 photograph of an unidentified staff geologist of the Fourth Pennsylvania Geological Survey in the field. The photograph was taken at the "Tobyhanna Encampment," believed to be the Boy Scout camp known as Camp Acahala, which is near the junction of the Lehigh River and Tobyhanna Creek in Tobyhanna Township, Monroe County, Pa. (see article on page 3).

EDITORIAL

Adaptability

Gale C. Blackmer, State Geologist
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In case you forgot, 2019 is the 100th anniversary of the Fourth Pennsylvania Geological Survey. The first three surveys were commissioned for limited periods of time to document specific aspects of geology (mostly related to mineral and energy resources) and, in the case of the Third Survey, topography. The Fourth Survey has a much broader mandate. To summarize the enabling legislation, our charge is to undertake a "thorough and extended" survey of the geology and topography of the commonwealth. The legislation specifically calls out a number of tasks: mapping and chemical analysis of mineral resources, energy resources, clays, soils, and fertilizers; locating and chemical analysis of waters; mapping and characterization of rock formations that would be useful in highway construction or for any other purpose; collecting specimens of the geological and mineral resources of the state; maintaining a geological library; working cooperatively with the U.S. Geological Survey (USGS) and other appropriate national organizations; and putting all of this information into "a form convenient for reference." Beneficiaries of the work named in the legislation are the agricultural, forestry, mining, metallurgical, and construction industries and the public.

As you read through this issue, you will see that over the years, the Survey has used the breadth of that mission to adapt to immediate needs of the times. Initially, coal and iron were king. Today, the fossil energy focus is on natural gas. Iron is no longer mined, but we are actively involved in assessing potential sources of rare-earth elements and other critical minerals. Programs covering geologic hazards, engineering geology, and environmental concerns became a big part of the Survey's work in the second half of our first century. Topographic mapping has evolved from partnering with the USGS to produce 7.5-minute quadrangle sheets to coordinating the collection of statewide lidar elevation data. Groundwater work came to include maintaining Pennsylvania's database of water-well records. "A form convenient for reference" now includes web services, databases, and GIS files. Education is not specifically called out in the legislation, although one might argue that it is embedded in the instruction to provide information to the public, yet it has become an increasingly important part of the Survey's work in recent times. Climate change was also not envisioned by our Founding Fathers, but much of our work now passes through a lens of climate change adaptation and mitigation.

The first century has been a good ride, with lots of great work and an interesting cast of characters. I wonder what adaptations the next century will bring?

Gale C. Blackmer

The Fourth Pennsylvania Geological Survey—Unlocking the Mysteries of Pennsylvania's Geology for 100 Years

Rodger T. Faill[1], John H. Barnes[2], and Gary M. Fleeger[2]
Pennsylvania Geological Survey

INTRODUCTION

During the sesquicentennial of the establishment of the Pennsylvania Geological Survey in 1836, an issue of *Pennsylvania Geology* (Pennsylvania Geological Survey, 1987, v. 18, no. 1) was dedicated to the history of the organization. It included individual articles on the four separate Geological Surveys that were created between 1836 and 1919. The First Geological Survey (1836–58) had the limited objective of producing a single series of reports. When this objective was accomplished, the Survey was disbanded by the Pennsylvania Legislature. The Second Geological Survey of Pennsylvania (1874–95) systematically investigated the geology of the state and produced a remarkable series of reports and maps, generally on a countywide basis. The leadership of the Second Survey attempted to convince the legislature to make it a permanent state agency but failed to do so. The primary objective of the Third Survey (1899–1919), formally known as the Topographic and Geologic Survey Commission of Pennsylvania, was to produce topographic base maps of the entire state at a scale of 1:62,500 in cooperation with the U.S. Geological Survey (USGS). The Third Survey also approved of a significant amount of geologic mapping, particularly for the western Pennsylvania coal fields and southeastern Pennsylvania, mostly published as USGS Folios. But beyond this, it did not have well-defined goals and was chronically underfunded by the state legislature—thus it was never able to mount and sustain a vigorous program of geological activity.

What follows is a revision and expansion of an article by our long-time colleague, the late Rodger T. Faill, on the history and accomplishments of the Fourth Pennsylvania Geological Survey (1919–present) (Faill, 1987). Following the article are several pages of additional photographs of events and activities over the past 100 years that we thought were worth sharing.

Geological knowledge of Pennsylvania was greatly advanced by the Second Survey, but the need for additional information persisted. The Third Survey's concentration on topographic mapping and its chronic underfunding did little to satisfy this need. Indeed, the legislature's appropriation for the Survey was vetoed by Governor Brumbaugh in 1915 because he considered it too small to accomplish meaningful work. With the entry of the United States into World War I, a limited appropriation was restored in 1917 (Dodge, 2009). The need was still unmet, however, and new legislation was crafted to establish a fourth survey having a broader mandate and increased, more assured funding. On June 7, 1919, the present Geological Survey was created as the Bureau of Topographic and Geologic Survey within the Department of Internal Affairs. The name was derived from the Topographic and Geologic Survey Commission, which was abolished by the new legislation. Richard R. Hice, State Geologist of the Third Survey, was asked by Governor Sproul to stay on as Acting State Geologist of the Fourth Survey, commencing on August 1, until George H. Ashley assumed the office of State Geologist on September 1, 1919 (Dodge, 2009).

[1] Deceased.
[2] Retired.

Perhaps the main reason the Fourth Survey has persisted and grown is because its objective has been one of continuing service to the commonwealth in particular, and the geological community in general. The Fourth Survey, commonly referred to as the Pennsylvania Geological Survey, was empowered to "undertake, conduct, and maintain . . . a thorough and extended survey of the State for the purpose of elucidating the geology and topography of the State." The enabling act spelled out a large number of activities, including locating and analyzing all types of minerals, resources, and useful rock formations; maintaining collections of samples; forming a library; cooperating with state and federal organizations; and perhaps most importantly, making the results available to the general public via published reports.

THE EARLY YEARS

It was natural that George Ashley (Figure 1) was named State Geologist of the newly created Fourth Survey because he had worked in Pennsylvania, and particularly with coal, for the first two decades of the twentieth century. He had been State Geologist of Tennessee for two years, but most of his prior experience had been with the USGS, most recently as Chief of the Coal Section, where he supervised the coal projects in the eastern part of the United States. In a way it is ironic (or perhaps fitting) that one so involved in coal should start in 1919, for in the midst of the economic upheavals following World War I, a major nationwide coal strike had closed most of the industry.

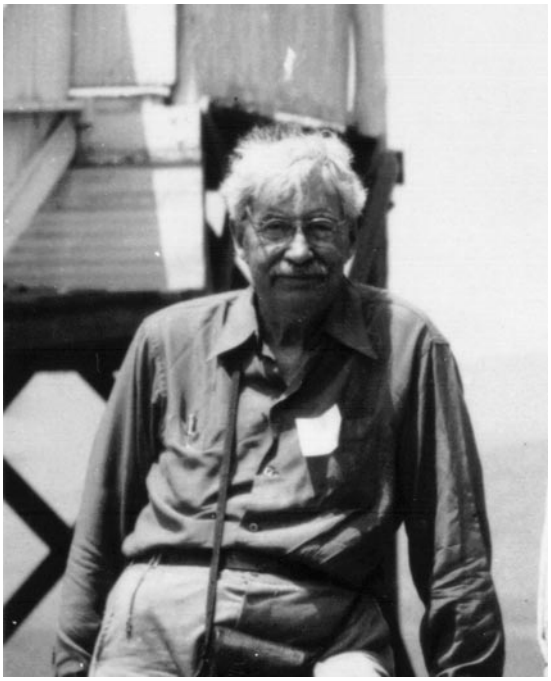

Figure 1. George H. Ashley in 1946, his 27th and final year as State Geologist.

But it was in natural gas, not coal, that the new survey made its first mark. The McKeesport gas field (Figure 2) was discovered in August 1919, and it promised to be a rich play. Ashley soon visited the area, but despite his warnings that excessive drilling would lead to large financial losses, drilling proceeded at a rapid pace. Within two years the overdeveloped McKeesport field was largely depleted. Ashley's interest in oil and gas may also be reflected in the fact that the first two Mineral Resource Reports were a report on the oil and gas fields of the state (Mineral Resource Report 1), prepared in cooperation with J. French Robinson of Peoples Natural Gas Company, and a report on oil resources in coals and carbonaceous shales (Mineral Resource Report 2), prepared in cooperation with Charles Fettke of Carnegie Institute of Technology (now Carnegie Mellon University), who had been a cooperating geologist with the Survey since 1914.

Coal, on the other hand, was not to be ignored (Figure 3). The uncertainties in supplies caused by the miners' strikes gave impetus to search for alternative sources. This underlay Ashley's instigation of culm bank and river coal studies. The highway department's need for limestone as road building material in northwestern Pennsylvania was also an early focus for the new organization.

Responding to the immediate needs of the commonwealth was, and still is, a primary responsibility of the Geological Survey, but Ashley recognized that a more systematic program was needed to answer future needs. Foremost in Ashley's overall plan was to produce a new atlas of Pennsylvania, comprising both a topographic and a geologic map of each quadrangle, patterned after the USGS Folio series. A start

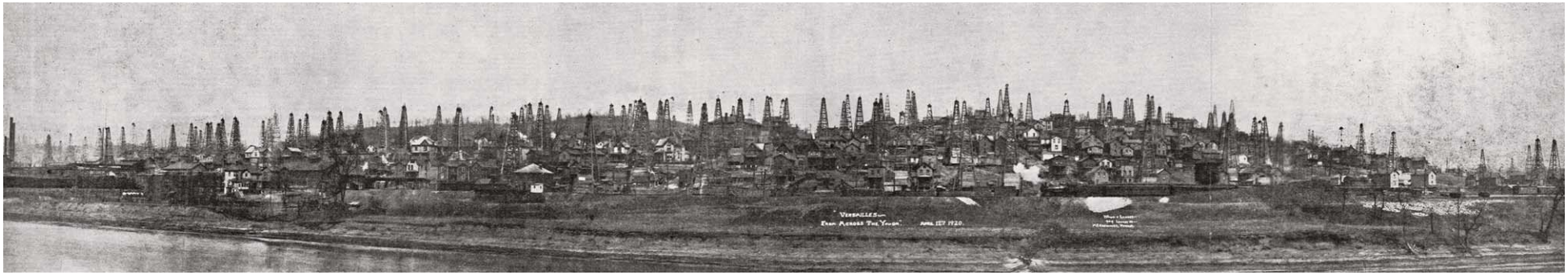

Figure 2. Panorama of the McKeesport gas field, taken when the gas boom was at its peak. This is the southern part of the field at Versailles, Pa., seen from across the Youghiogheny River. Photograph by Wood and Landes, McKeesport, April 12, 1920 (Johnson, 1929, Plate XXIII).

Figure 3. Staff geologist R. M. Foose at an outcrop of the "E" coal in Clearfield County, October 19, 1940.

had already been made by the Third Geological Survey. Mapping was being actively pursued, not only by USGS geologists (e.g., Charles Butts, M. R. Campbell, M. J. Munn, and George W. Stose), but also by academics (e.g., Florence Bascom, Eleanora Bliss [later Eleanora Bliss Knopf], and Benjamin L. Miller). Their efforts were concentrated in the coal measures of the Carboniferous and Permian rocks of southwestern Pennsylvania and the crystalline rocks in the southeastern part of the state.

Ashley needed a staff to carry out such an ambitious mapping program, so by the end of the first year he had hired four geologists and five support staff. Ten years later the number of geologists had grown to nine, a size at which the survey remained through the next 25 years (Figure 4). One of the better-known staff members was Bradford Willard, a paleontologist and Devonian expert who worked for the Survey throughout the 1930s and as a cooperating geologist in the 1940s and beyond. Another staff member was Ralph W. Stone, formerly of the USGS, who wrote, among other reports, *Building Stones of Pennsylvania.* In the 1920s, Charles H. Behre extensively studied the slate industry in Pennsylvania. Marchant N. Shaffner produced 3 Atlases in the Main Bituminous coal district. Anna I. Jonas (later Anna Jonas Stose) worked through the 1920s and 1930s in southeastern Pennsylvania and was, along with Stose, an enthusiastic and vociferous proponent of the overthrust concept as applied in the Piedmont and Reading Prong. This period was when the Survey produced, in 1932, one of its first publications aimed at a more general audience, *Meteorites Found in Pennsylvania,* appropriately enough authored by Ralph Stone and revised by Eileen Starr in 1967 (Figure 5).

But, as effective as this staff was, it was not enough, and in the early years of the Fourth Survey, Ashley contracted with 13 cooperating geologists to produce geologic maps. These geologists included such luminaries as Bascom, Miller, Edgar Wherry, and Charles Fettke, who, with other cooperating geologists, continued his work on the oil and gas resources of western Pennsylvania. Cooperative projects with the USGS involved Stose, Munn, M. E. Johnson, and G. B. Richardson, among others.

Figure 4. Photograph of staff members and cooperating geologists of the Survey taken during the Field Conference of Pennsylvania Geologists in 1946. Front row: Richard E. Sherrill (cooperator), Harry V. Gouse, William S. Lytle, Richard M. Foose, and Robert C. Stephenson. Back Row: George H. Ashley, Charles R. Fettke (cooperator), Marchant N. Shaffner, Ralph W. Stone, Anna Jonas Stose (cooperator), and Wilber H. Seifert.

Not having topographic maps (which provide an accurate base for mapping geologic formations) was a major disadvantage under which the Second Survey worked, and this may explain Ashley's intent to complete the topographic mapping of the state as soon as possible. When he took office, only 56 percent of the state's topography had been mapped, and thus the choices for geologic mapping were somewhat restricted. As a consequence, Ashley continued the cooperative program with the USGS that had been started by the Third Survey (Sevon, 1987; Dodge, 2009), in which the federal survey produced the maps and the state shared in the costs.

Dissemination of the geologic information is as important as the gleaning of it from the rocks, soils, and landscape, a fact that Ashley thoroughly understood. However, publishing at first was frustrated by a very slow state printing office, so much of the early material was issued in mimeographed form. By the end of the Fourth Survey's first decade, nearly 100 of these bulletins (now called Progress Reports) had been printed, along with 6 Atlases and 12 Mineral Resource Reports, which covered coal (both bituminous and anthracite), lead and zinc ores, oil and gas, slate, fire clays, limestones, and silica refractories.

In lieu of a completed atlas of Pennsylvania, Ashley planned a single geologic map of the entire state, which was finally published in 1931, done largely by cooperative geologists of the USGS (Stose and Ljungstedt, 1931). Much of this map was taken directly from the work of the Second Survey, but it

Figure 5. Ralph W. Stone inspecting the Bald Eagle meteorite on May 19, 1931, while working on General Geology Report 2, Meteorites Found in Pennsylvania.

also included the new work in the crystalline terrane of southeastern Pennsylvania, and the extensive mapping in the bituminous fields in the southwestern portion of the state.

Groundwater is the principal source of much of the water that is used in Pennsylvania, another fact not lost on Ashley. In 1923, Ashley initiated a cooperative program with the USGS to ascertain the groundwater resources for the entire state. Six regional reports and a statewide report were completed over the next 18 years, volumes that are still in use today.

From the 1930s into the 1940s, studies of oil fields continued as part of a national effort while worldwide political tensions increased. Most of the investigators were contractors from academia, such as Richard E. Sherrill (University of Pittsburgh) and Charles Fettke, and the oil and gas industry, such as Parke A. Dickey (Quaker State and Forest Oil Companies). One person who was hired for that effort, William S. Lytle, worked from his home in Pleasantville, Venango County, giving the Survey an informal base of operations in western Pennsylvania. This led to a formal office, the Oil and Gas Division, being opened in Butler, where Lytle later lived. Eventually, this operation moved to Pittsburgh, where the Survey has maintained a permanent office to the present time.

George H. Ashley retired from the Pennsylvania Geological Survey at age 80 on August 31, 1946, ending a 27-year career as State Geologist. By this time the topographic mapping of the state at the 1:62,500 scale was nearly complete. His plan for an atlas of the entire state was much farther from fruition, but geologic mapping is perforce a much slower activity. Even so, 11 Atlases and 6 County Reports were published, along with 19 General Geology Reports, 27 reports on mineral resources, 7 reports on groundwater, and 130 Progress Reports.

INTERREGNUM

Stanley H. Cathcart (Figure 6) was the next State Geologist, taking office on January 1, 1947, when Ralph W. Stone retired at age 70 at the end of his largely ceremonial four months as chief geologist of the Survey. Cathcart's earliest experience, with the USGS, was in metalliferous geology, but his subsequent years in overseas oil exploration with several petroleum companies provided him with a strong background when he joined the Fourth Survey in 1930. Cathcart was on the Survey staff from 1930 to 1937 and 1941 to 1943, before becoming State Geologist in 1947.

Oil and gas studies, in which Cathcart had been a major contributor, had been an important part of the Survey's activity over the years. Charles Fettke continued his studies, particularly on the Bradford

oil field and the deeper gas formations such as the Lower Devonian Oriskany Sandstone. Innumerable wells have been drilled for oil, and more recently for gas, since 1859, when Col. Edwin L. Drake drilled the first well in the United States, at Titusville, Pa., that was specifically designed for producing oil. Since the inception of the Fourth Survey, an effort had been made to record the locations and characteristics of every oil and gas well drilled in Pennsylvania. So many relatively shallow wells have been drilled over the decades that publishing the data on all of them would have been of little interest to most geologists. However, as drilling reached deeper unexposed formations, interest in these deeper wells increased. In 1950, Cathcart instituted a series of annual reports listing specific data from all recently drilled deep wells, along with general information on shallow wells. Also begun at this time was an annual report on the production of minerals in Pennsylvania.

Stanley Cathcart died in 1953. Ralph Stone came out of retirement to once again step in as Acting State Geologist for seven months until the next State Geologist was appointed.

Figure 6. Stanley H. Cathcart, State Geologist from 1947 to 1953.

REORGANIZATION

Carlyle Gray (Figure 7), a member of the staff since 1949, became Acting State Geologist in October 1953, and was formally appointed as State Geologist in October 1955. It was during this time that a change in focus and structure of the Pennsylvania Geological Survey occurred, with new objectives being defined.

The Great Depression of the 1930s and the ensuing war years had brought most of the quadrangle mapping in Pennsylvania to a halt. Finally, in the mid-1950s, Gray restarted a determined program of atlas mapping. Perhaps most important was the change of mapping scale to that of the new 7.5-minute series of topographic maps. Mapping at this larger 1:24,000 scale permitted much greater detail and accuracy, and it has been standard since. The enormous project of creating the 764 topographic base maps that were required to cover all of Pennsylvania at the new scale, and that made such detailed geologic mapping possible, was begun under the long-standing cooperative agreement between the USGS and the Pennsylvania Geological Survey in 1946. It was not completed until 1973. As of that year, Pennsylvania was the twelfth and the largest state to have complete coverage at that scale (Socolow, 1973).

The carbonates of the Great Valley in Lebanon County were the first target because of their importance to the steel industry that was present and growing there. It was also decided to map two corridors across the Ridge and Valley physiographic province, one north-south and the other east-west, to provide a three-dimensional framework, because so little work had been done in the central part of the state. Mapping in the bituminous fields (which had occupied so much effort in the early part of the century) continued, centered on Clearfield County, where production was increasing and new exposures

Figure 7. Carlyle Gray, State Geologist from 1953 to 1961, showing Genevieve Blatt, Secretary of Internal Affairs, geophysical well-logging tools at a Survey open house on March 5, 1957.

for study were becoming available as the area transitioned from underground to surface mining.

Mapping was not the only activity that accelerated during the latter part of the 1950s. An extensive study on the Cornwall iron mines in Lebanon County was commenced, along with a variety of other geologic subjects, including the geology of Bucks County; chromite mining; the paleontology of the Bloomsburg Formation; and the glacial geology of northwestern Pennsylvania.

The most recent geologic map of the state at this time, by Stose and Ljungstedt (1931), was based mostly on Second Survey work. Gray did not want a new version to be based on such dated material, but despite all the work the Fourth Survey had done up to that time, large areas of the state had not been evaluated since before the turn of the twentieth century. Accordingly, the entire geologic staff performed reconnaissance bedrock mapping of the entire state and compiled the new data on 15-minute quadrangle topographic maps. From these maps, a new geologic map (Gray and others, 1960) was assembled, more detailed and colorful than any of its kind before.

Groundwater studies in Pennsylvania tapered off in the early 1940s. A few reports were published in the next 10 years, but it wasn't until the late 1950s that studies on groundwater became widespread across the state. Since then, a steady stream of groundwater reports have appeared for quadrangles and counties, specific formations, specific lithologies, and watersheds.

The Survey made a significant technological advancement in 1956 when it acquired its first X-ray diffractometer (Figure 8) for more definitive mineral identifications. This was barely ten years after X-ray diffraction moved from being an experimental method to a more mainstream method with the introduction of the world's first commercial X-ray diffractometer in 1947.

With Carlyle Gray's resignation in September 1961, Alan R. Geyer stepped in as Acting State Geologist for the next three months.

GROWTH TO THE 1980s

Arthur A. Socolow (Figure 9) was named State Geologist at the end of 1961, having worked at the Pennsylvania Geological Survey since 1957. During the ensuing 25 years, the Survey continued to grow and expand its activities into new areas of applied research and evaluation. Throughout most of its history, the Fourth Survey was a bureau within the Department of Internal Affairs. In 1968, with the elimination of that department, the Survey became part of the State Planning Board. In 1971, the Bureau

Figure 8. Davis M. Lapham, Survey mineralogist, working in 1958 with the Survey's first X-ray diffractometer, acquired two years earlier.

of Topographic and Geologic Survey was transferred to the newly created Department of Environmental Resources (DER).

Geologic mapping remained the cornerstone of the Fourth Survey's activities. The study of the carbonates in the Great Valley in eastern and south-central Pennsylvania continued. During the 1960s and 1970s, mapping in the Ridge and Valley physiographic province in central Pennsylvania focused on the major population centers of Williamsport and Altoona and along major transportation corridors. Early in his tenure, Socolow decided that additional mapping was needed to help complete the northern parts of the Main Bituminous coal field. And in the late 1960s, mapping was begun in eastern Pennsylvania because of the expanding population growth there. This mapping has been continued into the northeastern part of the state where virtually no work had been done since the Second Survey. Fourth Survey geologists had not worked in the Anthracite region in eastern Pennsylvania or in the southwestern part of the state because USGS geologists were assigned to map those regions from the late 1950s to the early 1970s under a large 1:24,000-scale cooperative mapping program. At about the same time, several countywide coal-resource investigations were completed in western Pennsylvania under a cooperative agreement with the USGS. In the late 1970s, the Survey developed a coal exploration model by analyzing a small coal basin in Greene County. Also at this time, the USGS implemented the National Coal Resource Data

Figure 9. Arthur A. Socolow, fourth State Geologist of the Fourth Survey, from 1961 to 1986. Photograph by Socolow's son, Carl Socolow.

System (NCRDS), a computer-based program for storing detailed stratigraphic and chemical data on coals, from which coal thickness and quality maps could be generated and coal-resource estimates could be calculated. The Pennsylvania Survey's coal section devoted much time and effort over the next two decades mapping, interpreting, and compiling the geology and associated mined-out areas of the bituminous coal fields of western Pennsylvania on a countywide basis, and gathering and storing the voluminous coal data to create the maps in this computer system.

Perhaps one could say that 1972 was a watershed year for the Survey. For decades the Survey's headquarters occupied offices on the sixth floor of the South Office building in the Capitol Complex in Harrisburg. In March of 1966, the offices were moved to the former home of the State Museum, then called the Main Capitol Annex. Six years later, expansion of legislative offices in the adjacent Main Capitol Building pushed the Survey out—into a building in an abandoned channel of the Susquehanna River. No sooner had the Survey settled in when Agnes, the errant tropical storm, arrived in Pennsylvania, and stayed, and stayed, until the Survey's offices (and much else along the Susquehanna) were totally submerged (Figure 10). It took a while for the Survey to recover, but projects were soon underway again. Just as importantly, the generosity of many individuals went a long way in rebuilding the Survey's library, which had been totally destroyed.

By the mid-1970s it was felt that sufficient modern mapping had been done that a revision of the 1960 *Geologic Map of Pennsylvania* was in order. A number of the Survey's staff were engaged in this effort, which included a fair amount of reconnaissance work, utilizing aerial photographs extensively, and conceptual modeling of the distribution, depositional environments, and mappability of various lithostratigraphic units. After several years' effort, the map was published (Berg and others, 1980). The

Figure 10. The recently occupied offices and laboratories of the Pennsylvania Geological Survey being destroyed by the tropical storm Agnes flood in June 1972.

following year, the 624 black-and-white copies of 7.5-minute (and a few 15-minute) preliminary compilation maps, covering quadrangles that had not been published by the Survey or the USGS in another format, were released at 1:62,500 scale as Map 61 (Berg and Dodge, 1981). Three years later, the first correlation chart for Pennsylvania was printed (Berg and others, 1983).

Mineral studies have been in the forefront of Survey activities. In fact, one could argue that supplying geologic information for the extraction of mineral resources is the ultimate justification for any geological survey. Coal, and oil and gas, are the most valuable commodities in Pennsylvania, but numerous others have been studied over the years, such as manganese and chromite. In the 1970s and 1980s, studies were done on zinc and lead deposits, copper and uranium, carbonate whiting, barite, and high-purity silica, among other mineral commodities.

Much of the work by the Oil and Gas Division in the early Socolow years involved petroleum evaluations in various quadrangles of the western part of the state, in addition to an important stratigraphic study of the Lower Paleozoic formations in western and central Pennsylvania. Specific drilling-target horizons, such as the Medina sandstone, were also evaluated. Late in the 1960s, the Pittsburgh office created and periodically updated a new series of hand-drafted oil and gas maps at 1:62,500 scale. This series included every quadrangle in northern and western Pennsylvania that contained at least one oil or gas well, and showed the locations of these wells as well as the field/pool limits. In the 1980s, 1:24,000-scale topographic maps replaced the older series.

The need to examine and anticipate the effects of human activities on our environment, and the geological factors involved, steadily increased over the years and led to the creation of the Environmental Geology Division in 1968. A report on the engineering properties of the various rocks of Pennsylvania was the first product of this new division. The Division also engaged in water studies, the first of which was for the Susquehanna River Basin Commission (SRBC). Other activities of the division included studies on landslide potential, sinkhole development, and environmental geology of metropolitan areas.

Cooperative groundwater studies with the USGS increased during the 1960s and 1970s, particularly in north-central and northwestern Pennsylvania, and included much original, detailed geologic mapping. As the cooperative program declined in the 1980s, the Survey's Environmental Geology Division undertook a series of groundwater-resource studies in several river basins; much of the work was prepared in cooperation with the SRBC.

In keeping with the policy to disseminate geologic information produced by the Survey as widely as possible, Socolow instituted three new publication series that have proved to be as popular as they are informative. *Pennsylvania Geology* (Figure 11), a magazine begun in 1969, provides timely announcements and geologic descriptions for professional and amateur geologists, as well as interested laypersons. The Educational Series, begun in 1962, contains discussions, in nontechnical terms, on broad aspects of geology, such as coal, the Ice Age, groundwater, and geologic hazards. The geologic Park Guides (now included in the Trail of Geology series) were begun in 1969 and now number 22. These guides describe in nontechnical language the geology within and surrounding various Pennsylvania state parks. The Survey also published guidebooks in the 1960s listing good places to go for mineral and fossil collecting. These proved to be so popular that many of the sites were soon over-collected; eventually, the publications were no longer made available.

The Survey acquired what is believed to be its first computer in the late 1960s, an Olivetti Programma 101, which is considered by some to be the world's first programmable desktop computer. After the Programma 101 became a victim of the Agnes flood in 1972, the Survey moved up to a more

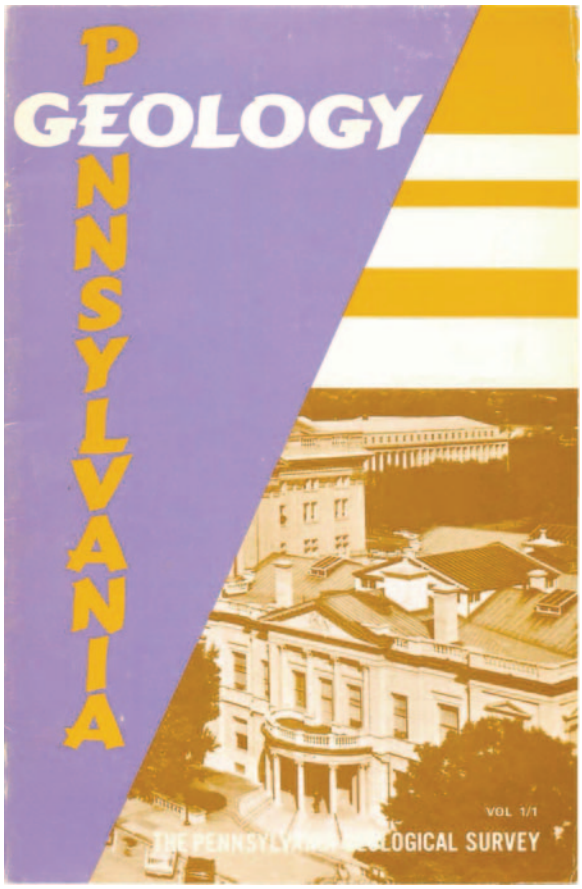

Figure 11. The cover of the first issue of Pennsylvania Geology *from 1969, showing the Main Capitol Annex, which was the Survey's home at the time.*

powerful Programma 602, and later an Apple II Plus (Figure 12), both of which could be interfaced with the X-ray diffractometer to add a bit of automation to the collection of diffraction data for large studies, such as the clay-shale project in the 1970s that involved hundreds of samples.

In the early 1980s, various desktop computers for simple database and statistical operations, and terminals that connected the Survey to the outside world, began appearing around the Harrisburg and Pittsburgh offices. It wasn't long before everyone at the Survey had a personal computer on his or her desk.

Also in the early 1980s, the Survey acquired the Oil and Gas Regulatory Division from the Bureau of Mining and Minerals. To avoid confusion, this required the Oil and Gas Division to change its name to the Oil and Gas Geology Division. Responsibility for overseeing a regulatory organization was an unfamiliar task that took up an inordinate amount of Socolow's time. In 1984, the Oil and Gas Regulatory Division was transferred to DER's Environmental Protection Deputate and raised to the level of a bureau, where it remains to this day. As a result, Socolow was able to spend his remaining years with the Survey focusing on more appropriate geological issues.

Arthur A. Socolow retired in August of 1986, leaving the Survey with a staff of 43, which had accomplished a remarkable amount of work during his long tenure.

After serving as Acting State Geologist for five

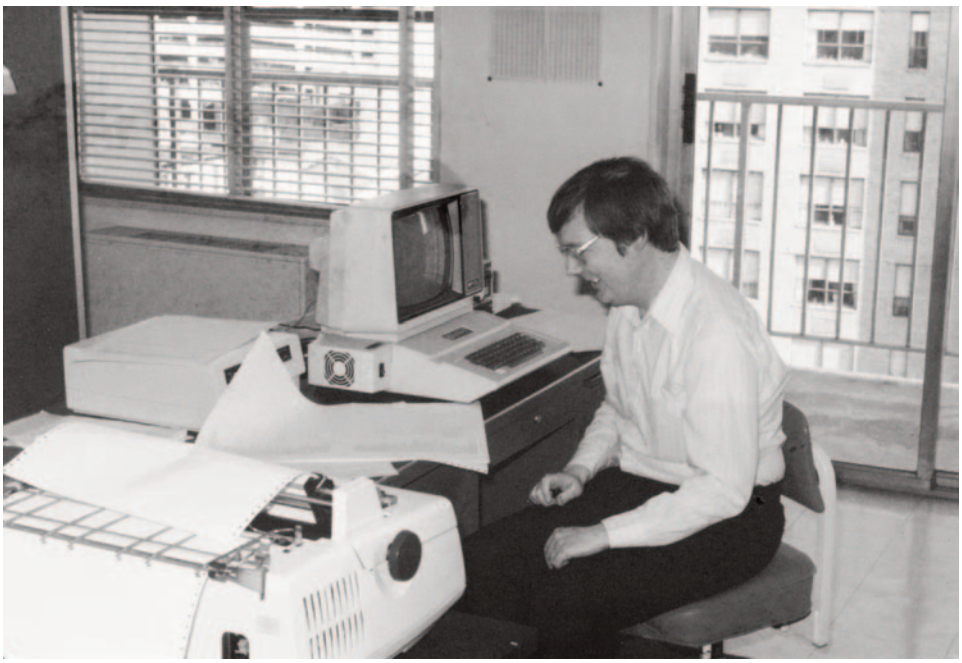

Figure 12. Staff geologist John Barnes working at an early desktop computer circa 1980. This was the third Survey computer, an Apple II Plus, which was interfaced with the X-ray diffractometer to improve data collection.

months, Donald M. Hoskins (Figure 13) was appointed the fifth State Geologist of the Fourth Survey on January 8, 1987. Hoskins arrived at the Survey in November 1956 and received his Ph.D. from Bryn Mawr College shortly thereafter (Berg, 2000). He served as an editor and, for many years, as Assistant State Geologist under Socolow. While holding that position, he attended evening classes to earn a master's degree in government administration.

In 1989, the Survey became a research partner with adjoining states in the Appalachian Oil and Natural Gas Resource Consortium (AONGRC), a public/private partnership headquartered at West Virginia University. Over the years AONGRC has utilized federal and industry funding to produce a series of topical studies on hydrocarbon reservoirs of interest, such as the Cambrian Rose Run sand and the Ordovician Trenton and Black River limestones. The consortium also produced the large format (22 x 17 in.) *Atlas of Major Appalachian Gas Plays* (Roen and Walker, 1996), which proved to be very popular with the United States natural gas industry.

Figure 13. Donald M. Hoskins, fifth State Geologist of the Fourth Survey, from 1987 to 2000.

A significant administrative change took place about halfway through Hoskins' tenure as DER was split into two departments, the Department of Environmental Protection (DEP) and the Department of Conservation and Natural Resources (DCNR), effective July 1, 1995. The Survey was placed in DCNR, which remains its administrative home at the present time. The split was intended to place the environmental regulatory and enforcement bureaus in DEP, and the bureaus that provide services (such as managing and maintaining the State Parks and State Forests, providing funding for conservation and recreational activities, and providing information on the state's natural resources, including geology) in DCNR.

THE CONTINUED ADVANCEMENT OF TECHNOLOGY

Hoskins' appointment came at a time when the use of digital technology in all sectors of society was becoming more sophisticated and more common. In the early 1990s, one computer application that Hoskins embraced wholeheartedly was digital mapping. He required all geologists to participate in several days of training to learn how to use geographic information system (GIS) software for the creation of maps and the plotting of spatial data.

Recognizing the growing role of digital technology, the Geologic and Geographic Information Services Division was created in 1992 as part of a reorganization of the Survey. That reorganization also brought about the elimination of the Environmental Geology Division, although its functions continued to be carried out by its former staff members, who were reassigned to the Geologic Mapping Division (Figure 14).

Figure 14. Donald Hoskins addressing a staff retreat at Kings Gap Environmental Education Center, probably in 1987.

In 1996, Hoskins proudly announced through his editorial in *Pennsylvania Geology:* "We're on the web!" (Hoskins, 1996). Within a short time of that announcement, publications began appearing on the Survey's website, one of the first being Map 61.

In 1997, the movement of data to the Internet began when two digital versions of the *Directory of the Nonfuel-Mineral Producers in Pennsylvania* were published on the Internet. The directory had been published and updated as a series of booklets since 1965. It contained the names and contact information for producers of aggregate, dimension stone, and other nonfuel resources, as well as information on their locations, what they were mining, and what their marketable products were. From the beginning, it has been a useful method for the producers of such resources and their potential customers to locate each other. One digital version that was put online in 1997 was a simple PDF image of the printed book and another was a set of files that could be downloaded into common programs such as Microsoft Excel. In 2000, an interactive version that could be downloaded and used with GIS software was made available.

In 1994, the Survey created the Wells Information System (WIS) for entering oil and gas well data into a digital database, but the data could be accessed only within the Pittsburgh office. Clients requiring digital data had to use an office computer and printer set up specifically for that purpose or request that the data be downloaded to a compact disc (CD) and mailed to them. In 1999, in partnership with numerous oil and gas companies, the Survey initiated the Pennsylvania Internet Record Imaging System (PA*IRIS) to provide online access to information on thousands of oil and gas well records that had been scanned using the Survey's files. Access to PA*IRIS was free to anyone who visited either Survey office or, for a subscription fee, outside users could access it from any place having an Internet connection.

In 1998, the way in which water-well data were collected and distributed to the public was revolutionized. The Internet application, WebDriller, was created to allow drillers of water wells to digitally provide to the Survey the well data that they had previously been required to mail in on paper forms. The data collected using WebDriller was then transferred automatically to another new computer application, the Pennsylvania Groundwater Information System (PaGWIS), which was created to provide better access to water-well data. Access to the PaGWIS system was not immediately available over the Internet, but requests for information could be answered through a visit to either Survey office or through the purchase of a CD containing the database.

The release of other kinds of data online soon followed. This desire to get information into the hands of the user as quickly and efficiently as possible led to significant changes in how reports were released to the public.

OPEN-FILE FORMAT

The open-file format of publishing had been used only sparingly before Hoskins became State Geologist. Open-file publication makes it possible for the information to get from the geologist to the user much faster. The caveat is that this is made possible by bypassing some of the standard procedures for more formal scientific publication, such as detailed critical review of the report by several of the author's professional peers, and by eliminating various editorial procedures. In some cases, high-quality, professional drafting of maps was also bypassed, although the introduction of GIS software allowed high-quality maps to be prepared much more quickly than by using traditional methods.

Under Hoskins, 72 Open-File Reports were issued. Forty-six of them were maps of the surficial geology of quadrangles in eastern Pennsylvania, 14 were maps of sinkholes and other karst-related features in southeastern Pennsylvania and the Great Valley, and the rest covered a variety of topics, including coal-bed methane, stratigraphic correlation charts, and groundwater quality. In addition to these reports, for which the open-file format was the final product, several maps that were intended for later release with accompanying text as part of formal publication series, such as Atlas reports, were first published as Open-File Reports to expedite releasing the basic information to the public.

Traditional reports, many initiated by Socolow, continued to be published during Hoskins' tenure as well. Three Atlas reports, including the Altoona 15-minute quadrangle (as four 7.5-minute quadrangles), the Washingtonville and Millville 7.5-minute quadrangles, and the Allenwood and Milton 7.5-minute quadrangles, were released, as was a County Report covering Pike County. The Survey also issued 2 Environmental Geology Reports; 6 Progress Reports, mostly on annual oil and gas developments; the final 3 mineral industry Information Circulars; 10 Water Resource Reports; and several new entries to the map series. Additional new Park Guides and Educational Series booklets were also issued.

NEW MAPPING PRODUCTS

The Survey's long-standing support of USGS topographic mapping continued with the completion of two new series that had been started during Socolow's tenure. One, completed in 1989, was a series of 1:50,000-scale county topographic maps (derived from the 7.5-minute quadrangle series) that could be of value to county officials and planners, and others who needed to see the big picture for their counties without dealing with piecemeal quadrangle maps. The other, completed in 1990, was a series of metric maps, each covering an area of 1 degree of longitude by 30 minutes of latitude at a scale of 1:100,000, where 1 centimeter equals 1 kilometer, with a contour interval of 20 meters.

Meanwhile, new types of maps began to be produced, including the release in 1989 of a 1:250,000-scale Harrisburg 1- by 2-degree map that was based on Landsat imagery and, in 1999, the first digital shaded relief map of Pennsylvania, Map 65.

NEW ENVIRONMENTAL ISSUES

An important environmental issue that emerged toward the end of Socolow's tenure was that of indoor radon. The presence of radon in small quantities in nature had long been known, but in the late 1980s, a house that had the highest concentration of indoor radon that had ever been recognized up to that time was found in the Reading Prong (Smith and others, 1987). The Survey began cooperative work with DEP's Bureau of Radiation Protection (BRP) to identify areas where radon was likely to be a problem. The Survey, by coincidence, had been undertaking a detailed study, begun under Socolow, of uranium and thorium in the Reading Prong at the time of this discovery. That study had generated a detailed map showing radioactive anomalies along roads in the Reading Prong, a simplified version of which was published ahead of the planned schedule to aid BRP in their community outreach efforts. Additionally, a table of uranium and thorium analyses for the Reading Prong was published online in 1997. The Survey also completed similar surveys of radioactive anomalies in other parts of the state for BRP between 1984 and 1989 and has continued cooperative work with BRP on this topic to the present time.

Another important issue that arose at this time, and that has had ongoing consequences, was a magnitude 5.2 earthquake that occurred on September 25, 1998, in northwestern Pennsylvania near Pymatuning Lake in Crawford County. The most significant long-term effect of the earthquake was a major disruption of the local groundwater hydrology that resulted in the loss of water to over 100 household wells near the epicenter while, in other places, new springs and wells started to flow. A cooperative study between the Pennsylvania Geological Survey and the USGS presented interpretations of the causes of the changes (Fleeger and others, 1999).

A VERY SPECIAL PUBLICATION

A crowning achievement for the Survey that occurred during the Hoskins era was the completion of Special Publication 1, *The Geology of Pennsylvania,* in 1999. First conceived in 1983 and taking about 15 years to complete, this 888-page hardcover book was co-published by the Survey and the Pittsburgh Geological Society. It contains more than 800 illustrations and was prepared by 90 specialists in various aspects of geology from academia, government, and industry, including 14 Survey staff members. The enormous task of preparing this massive manuscript for publication was done by the Survey's editorial and drafting staff. The book, which is divided into ten parts, covers all aspects of the geology of the state. It proved to be such a popular book that it had to be reprinted three years after first being released.

After 14 years as State Geologist, Donald M. Hoskins retired on January 27, 2001. At the time of his retirement, the Survey had a staff of 40, including 28 geologists. Hoskins continued his association with the Survey as a volunteer until his death 18 years later. He especially enjoyed going into the field with interns, mentoring them on mapping methods and the stratigraphy of the Ridge and Valley physiographic province.

Following Hoskins' retirement, Samuel W. Berkheiser graciously served as Acting Director from January until June 2001, when Jay B. Parrish (Figure 15), a geophysicist who had experience in remote sensing and, most recently, had been director of GIS activities for Lancaster County, assumed the position of State Geologist. Parrish had previously worked at the Survey in 1975 and 1976 as a student intern. It is no surprise that, with his professional background, the Parrish years had a continued emphasis on and expansion of technological progress at the Survey.

Figure 15. Jay B. Parrish, sixth State Geologist of the Fourth Survey, from 2001 to 2010.

DIGITIZING PENNSYLVANIA

A major accomplishment by Parrish was the establishment of PAMAP. This program provides statewide coverage of lidar imagery and high-resolution aerial photography (orthorectified and georeferenced). Over a period of 6 years, all of Pennsylvania was flown to collect data, and Pennsylvania became one of the first states in the nation to achieve complete coverage. The lidar elevation data were then used to create bare-earth digital-elevation models from which were derived much more detailed and accurate topographic contours. This procedure has been expanded nationally by the USGS in the National Map program. The lidar and aerial imagery provided benefit to a variety of industries, agencies, and the public. For the Survey, the imagery afforded the most detailed and accurate base maps for geologic mapping. Because all the data are digital, they allow expanded automation in plotting data and mapping in GIS. All of these digital products are available at no charge to the public through The Pennsylvania State University's Pennsylvania Spatial Data Access service (PASDA).

In addition to lidar and PAMAP, Parrish also was instrumental in making the Survey a partner with DEP and Penn State in the creation of the Pennsylvania State Seismic Network. The network, which first went online in 2004, consists of 30 seismic stations, including one at the Survey, that record data continuously at 100 samples per second, monitoring seismic activity across the state.

Other technological advances in the 2000s included the acquisition of the Survey's first scanning electron microscope. This instrument, equipped with an energy dispersive spectrometer (EDS) and cathodoluminescence detector (CL), for the first time allowed firsthand detailed examination of the habit and chemical composition of minerals and the distribution of chemical elements in a sample at the microscopic level. The CL detector can provide clues to the crystallization history of minerals, among other things. This equipment has been employed in numerous projects since its acquisition in 2002.

More of the Survey's existing data were converted to digital formats and entered into digital databases in the 2000s, allowing for much easier and more efficient data extraction. WIS and PA*IRIS were upgraded and replaced by the Exploration and Development Wells Information Network (EDWIN) for storing and accessing oil and gas well data. Access to PaGWIS was made available on the Internet, eliminating the need for users to visit the Survey office or purchase CDs in order to obtain water-well data. Progress was made in providing reasonably accurate locations for water wells by using in-office digital tools that greatly increased the speed and accuracy of locating water wells over locating in the field or on paper topographic maps. A large backlog of over 150,000 water-well records, previously available only on paper records in the office, was added to the database. Upgrades were also made for access to information in the *Directory of the Nonfuel-Mineral Producers in Pennsylvania*.

Parrish initiated an extensive effort to ensure that future field notes will be digitized. A stratigraphic database was created where detailed field data are entered. When populated with data, it will make

searching for past information at field sites much more efficient and easier to access than having to pore through many handwritten field notebooks. This database continues to evolve, making it more efficient and expanding it to allow entry of more types of data, including direct entry through connected devices in the field.

In addition to modern aerial photography acquired as part of PAMAP, the Survey library has, for years, been a source of statewide aerial photography from various government agencies dating from the late 1930s through more recent times. During the Parrish years, many of the photographs, particularly those produced by the U.S. Department of Agriculture, were scanned and made available to the public through Penn Pilot, which is administered by The Pennsylvania State University.

In 2002, the Survey's headquarters moved from Harrisburg to a modern office building outside of Harrisburg, near Middletown, known as the R. E. Wright Building. For the first time, this building provided space for on-site core storage. Core storage had, for many years, been in a series of buildings, some without heat or power, and mostly in a location in Clearfield County that is not convenient to either Survey office. This move made the study of core by staff, industry, and academia much more convenient and efficient. This facility has been visited by researchers from institutions around the world (Figure 16).

Geologic mapping remained a basic function of the Survey, with most bedrock mapping concentrated in central and eastern Pennsylvania. Surficial mapping in northeastern Pennsylvania

Figure 16. After moving to its present headquarters in Middletown, Pa., in 2002, for the first time, the Survey had space on-site for a core library that has benefited Survey staff and researchers from many other institutions.

continued as contract work using federal STATEMAP grants, which also provided funding for bedrock geologic mapping, particularly in areas undergoing development of the Marcellus gas play. After the Survey joined the Great Lakes Geologic Mapping Coalition in 2009, a bedrock topographic mapping program began in northwestern Pennsylvania to characterize the shape of the land beneath the glacial sediment cover. Efficient bedrock topographic mapping was made possible by the digitization of the water-well data, as well as the use of GIS.

ADJUSTING TO A CHANGING WORLD

As a result of climate change issues, the Survey has engaged in several initiatives aimed at finding ways to reduce the amount of carbon dioxide in the atmosphere through sequestering it in underground reservoirs and through using it in enhanced oil-recovery technologies. These initiatives include joining with several other states in the Midwest Regional Carbon Sequestration Partnership (MRCSP) in 2003 to locate appropriate subsurface geologic reservoirs to facilitate carbon capture and sequestration technologies; participating in the Carbon Management Advisory Group (CMAG) beginning in 2008; engaging in the Carbon Sequestration Technical Assessment (CSTA) beginning in 2009; and joining another multistate initiative to explore possible sites for carbon sequestration, the Mid-Atlantic U.S. Offshore Carbon Storage Resource Assessment (MAOCSRAP), in 2016.

Shale-gas exploration and development in the eastern United States began in the mid-1990s and has increased significantly in recent years. The Survey, which had been part of the Eastern Gas Shales Program (EGSP) in the late 1970s, began detailed studies of Marcellus, Utica, and several Upper Devonian shale reservoirs. A major upgrade to the Survey's X-ray diffraction equipment helped make some of this work possible.

Publication of maps and reports changed from mostly paper products to digital products during the 2000s. The benefits of producing digital products included the following: 1) it allowed users to print and use maps and reports in a traditional manner; 2) it provided an easy way to import files into GIS, which had become commonplace; and 3) it significantly reduced publication costs. A change that was noticed by readers of *Pennsylvania Geology* was its transition in 2009 from paper to an online publication. All issues from its beginning in 1969 to the present are now available online. In addition to increased use of digital publication techniques, the use of the open-file system of publishing was also expanded during this time in order to expedite the release of the results of the Survey's work.

After nine years as Bureau Director, Jay Parrish resigned. At that time, the Survey had a staff of 34, with 25 geologists. George E. W. Love (Figure 17), Assistant Director, became State Geologist in 2010. Love came to the Survey in October 2006 after a career in the mineral extraction industry, bringing many years of experience in management.

Following the successes of partnerships with other states and federal agencies, academia, and private industry (e.g., EGSP, AONGRC, PA*IRIS, and MRCSP), the Survey joined other partnerships, particularly those associated with hydrocarbons, such as the Appalachian Storage Hub (ASH) project, and with carbon capture and sequestration, such as the MAOCSRAP.

In 2012, the Survey announced that almost all publications, both past and future, would be available as free downloads on the Internet[1]. Soon after, in March 2014, the Pennsylvania GEOlogic Data Exploration web application (PaGEODE), a multipurpose geologic mapping application, became available online. PaGEODE can be used for finding publications by the topics and areas that they cover, in addition to providing other functions.

[1] Accessible at https://www.dcnr.pa.gov/Geology/PublicationsAndData/Pages/default.aspx.

In 2014, the Survey initiated a systematic program to map the bathymetry of State Park lakes, prioritized by the Bureau of State Parks. The maps, now numbering 43, are released as Open-File Reports.

George Love retired in 2015, leaving a staff of 34, including 25 geologists. Gale C. Blackmer (Figure 18) was appointed Acting Director and then Director in November of that year.

Figure 17. George E. W. Love, seventh State Geologist of the Fourth Survey, from 2010 to 2015, on a Marcellus Shale outcrop.

Blackmer had been a Survey geologist since 1999, when she was hired as a direct result of a strategic planning study led by Donald Hoskins, which had provided the conclusion that there was a need for modern geologic mapping in southeastern Pennsylvania. Prior to working at the Survey, she had worked for consulting firms and taught at several colleges, most recently at West Chester University. She served as supervisor of what was then called the Eastern Mapping Section from 2006 to 2010, and was manager of the Geologic Mapping Division from 2010 until her appointment as State Geologist. She is the eighth and current State Geologist of the Fourth Survey.

A major project that was undertaken by Blackmer immediately after her initial hiring in 1999 was mapping the Piedmont in southeastern Pennsylvania using STATEMAP funding and working collaboratively with the Delaware Geological Survey. This produced a block of maps covering most of the Piedmont from Philadelphia to the Susquehanna River. More recently, she has been extending her work into the Great Valley.

In the four years since her appointment, technological innovations have continued with the acquisition of a handheld X-ray fluorescence spectrometer that can be taken into the field to determine the chemical composition of rocks in situ, a drone to provide a better view of geologic features from above, and a passive seismic measurement unit to efficiently determine the depth to bedrock beneath surficial sediments. The latter instrument is being employed in the studies of bedrock topography under glacial deposits in northwestern Pennsylvania.

The Survey has recently been involved in developing statewide base layers. Much effort has been expended over the past two years to coordinate a second round of complete lidar coverage of the state, 10 years after the initial PAMAP coverage. Much has changed in the intervening 10 years, and advances

Figure 18. Gale C. Blackmer, current State Geologist (since 2015).

in technology have enabled higher resolution data at a lower cost. The Survey has also recently undertaken to develop and maintain a modern hydrography layer tied to elevation.

Recent Survey activities include, among other things, bedrock geologic mapping of the Broad Top plateau, in the Laurel Highlands, and in northeastern and north-central Pennsylvania; continued work on surficial geology in northwestern Pennsylvania; and ongoing investigations of various resources, such as rare-earth elements in coal, coal-bed methane, and serpentinite and other nonfuel minerals. Cooperative groundwater work with the USGS has increased during the past decade as a result of deep core drilling and geologic mapping by the Survey in areas undergoing Marcellus gas development in northern Pennsylvania. The boreholes have provided opportunities for studying deep groundwater systems and determining depths to deepest fresh groundwater. Other projects include a cooperative geologic study to identify potential reservoirs for secure storage of petroleum hydrocarbons near the Ohio River, and continued cooperative work with other states in identifying secure storage sites for captured carbon dioxide.

As has been true throughout the history of the Fourth Survey, there remains a culture of service to all who can benefit from knowledge of Pennsylvania's geology. The results of our investigations have always been made available at little or no cost to those who would benefit from them. Also true from the beginning, we continue to answer specific requests for assistance that can range from simple specimen identifications for individuals to assisting other state agencies with complex problems such as locating sites for water wells in state parks and providing expert assistance in dealing with serious environmental issues involving such things as radon, acid drainage, landslides, and sinkholes.

One hundred years after it replaced the Topographic and Geologic Survey Commission, the Bureau of Topographic and Geologic Survey was officially renamed the Bureau of Geological Survey in February 2019. The new name not only more closely matches the informal name by which the Survey has been known for most of its existence, "The Pennsylvania Geological Survey," but it also reflects a century of study and dissemination of information about all branches of the geological sciences. This centennial year sees the Survey with a staff of 33, including 23 geologists, plus a significant cadre of volunteers and students.

ACKNOWLEDGMENTS

The authors wish to acknowledge the assistance of John A. Harper, retired manager of the former Mineral Resources Division, Clifford H. Dodge, Senior Geologic Scientist in the Geologic Mapping Division, and former and current State Geologists, Jay Parrish, George Love, and Gale Blackmer for their thoughtful and detailed reviews that significantly improved this manuscript. Discussions with Robert C. Smith, II, retired supervisor of the former Mineral Resources Section, were also very helpful on a number of topics. We also thank Jody Smale, the Survey's librarian, for her kind assistance in helping us locate archival photographs.

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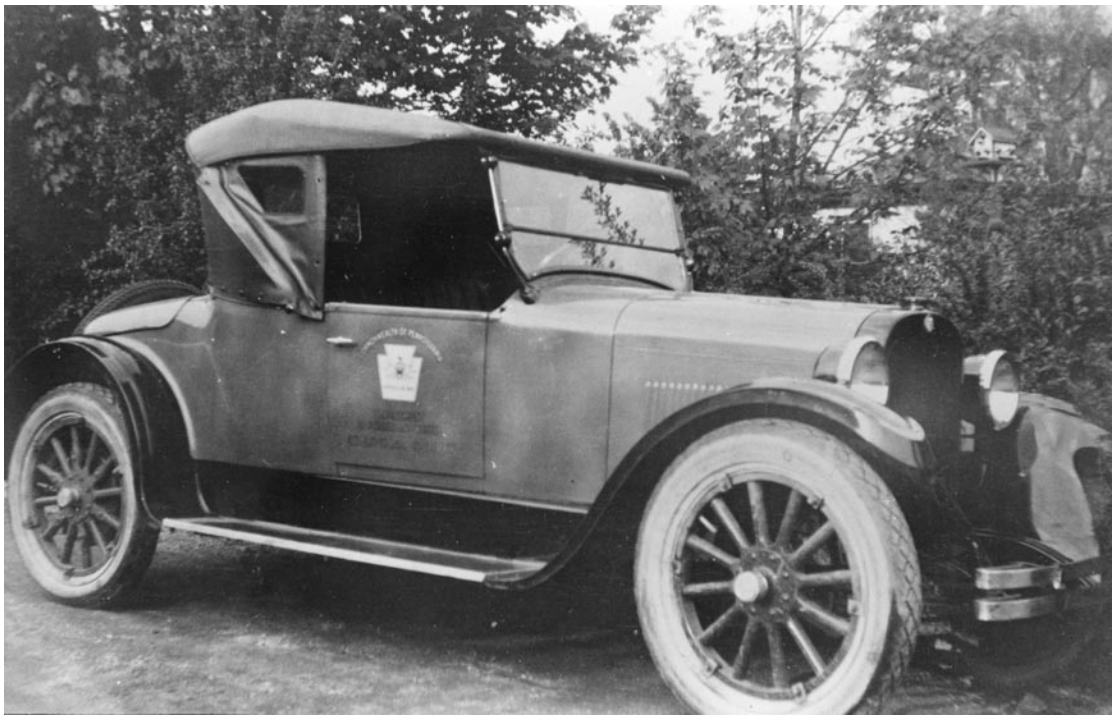
100 Years of Photographs

John H. Barnes and Gary M. Fleeger
Pennsylvania Geological Survey (retired)

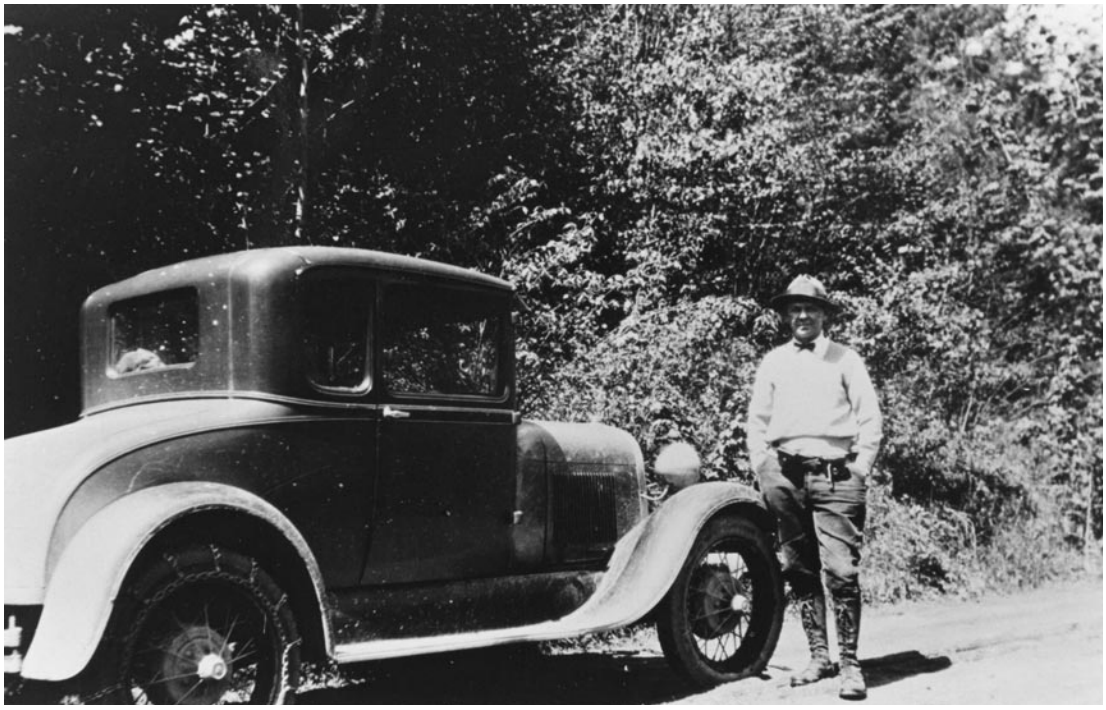
The Fourth Geological Survey of Pennsylvania was created at an exciting time of change in America, a time when many things that we take for granted were starting to become common, such as the electric light bulb, the telephone, the automobile, and photography. The camera quickly became an indispensable tool for the geologist, making it possible to record observations in the field and include them in their reports for all to see. Those cameras also gave geologists a chance to record their activities and images of themselves, often posing for pictures with that other new indispensable tool that made getting to and from the field site so much easier than before, the automobile.

Here are some photographs among hundreds that we found, sampling some activities of Fourth Survey geologists from the 1920s to the 2000s.

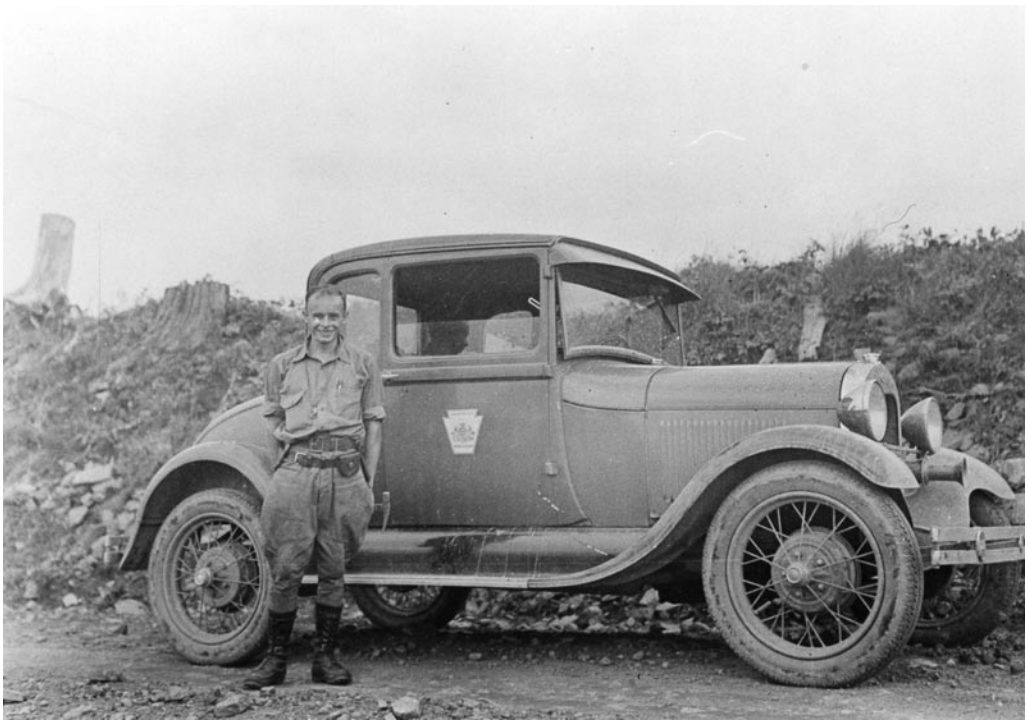
Staff geologist Meredith E. Johnson is assisted by Olin G. Bell of Cornell University, mapping with plane table and alidade near Pittsburgh in the summer of 1921.



A new Dodge Roadster acquired by the Survey in April 1925. Photographed on May 8, 1925.

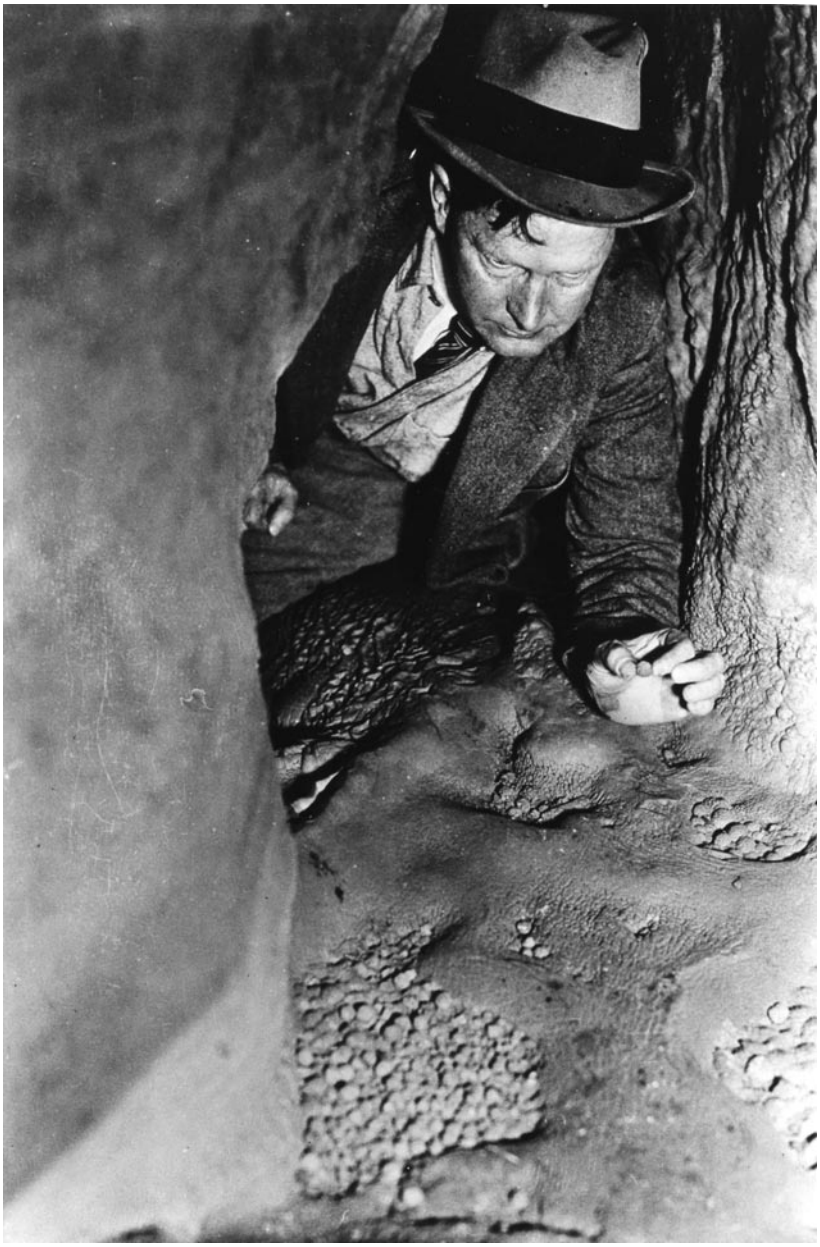


Future State Geologist Stanley Cathcart with his field vehicle in 1931.

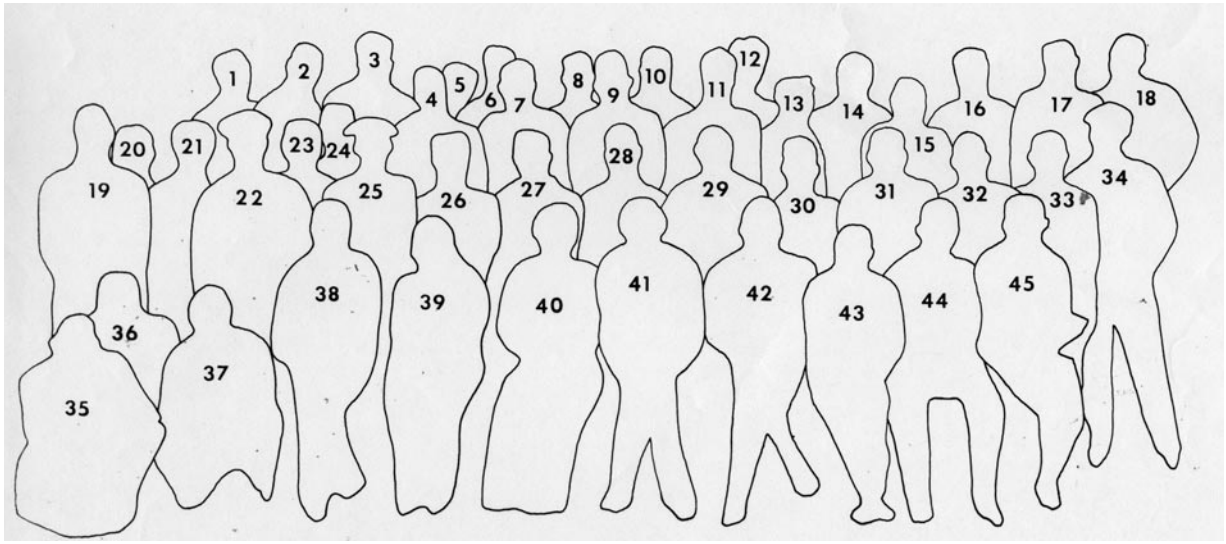


Staff geologist Marchant "Mike" Shaffner posing with his field vehicle in 1931.

Perhaps the reason that geologists like to pose for photographs with their field vehicles is that, in some parts of the state, the vehicles had to provide more than transportation. Here, an unidentified Survey geologist is shown using his vehicle as the centerpiece of his overnight accommodation. (From Ashley, G. H., 1934, Fifteen years—September 1, 1919 to September 1, 1934: Pennsylvania Geological Survey, 4th ser., Miscellaneous Paper 5, p. 6.)



Staff geologist Ralph Stone exploring a cave on May 20, 1931. Stone, who also was to serve as interim State Geologist twice, had a strong interest in caves, authored a report of caves for the Survey in 1930, and was President of the National Speleological Society from 1948 to 1950.



Group photograph of attendees of the third Field Conference of Pennsylvania Geologists in 1933, which focused on a variety of places ranging from the Cornwall iron mine in Lebanon County to Third Mountain, the Susquehanna and Juniata Valleys, South Mountain, and western Perry County. Identified attendees (Survey staff and cooperators in boldface) are as follows.

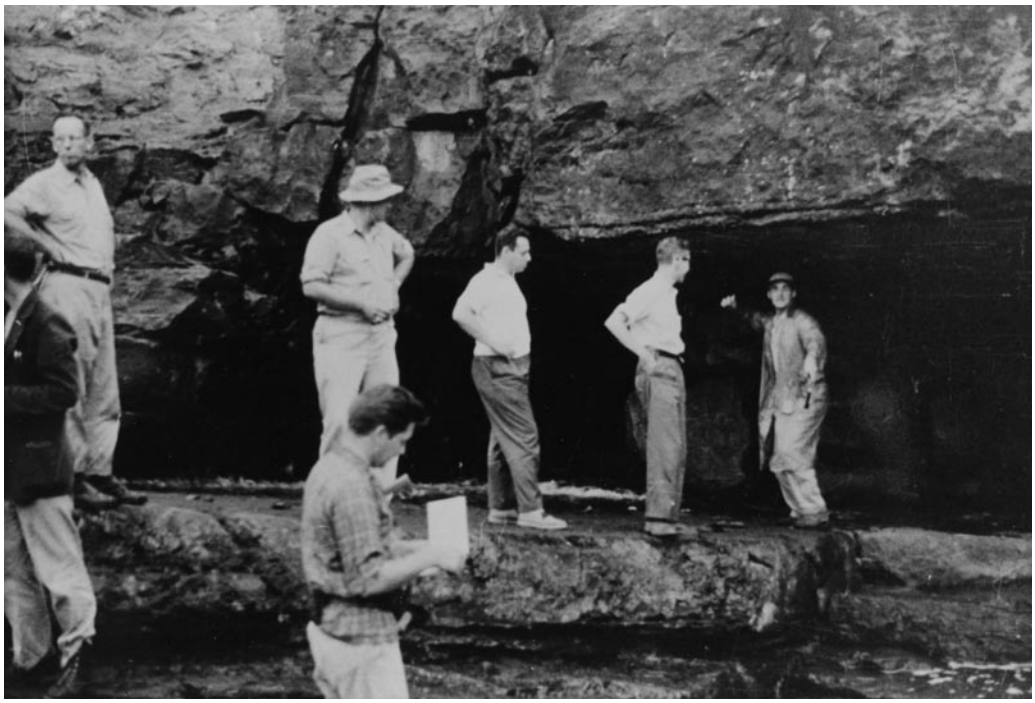
1. ***G. H. Chadwich?, cooperator***
2.
3.
4. ***C. A. Bonine, cooperator***
5. ***Henry Fretz, cooperator***
6.
7.
8.
9. *Joe Peoples (sp?)*
10. ***Charles Graeber?, staff***
11.
12. *Ed Watson?*
13.
14. *D. M. Frazer*
15.
16.
17.
18.
19. *H. M. Fridley*
20. *Kenneth E. Caster*
21.
22. ***Freeman Ward?, cooperator***
23. *Tolmachoff*
24.
25. ***Charles R. Fettke, cooperator***
26. ***Frank M. Swartz, cooperator***
27. *Lincoln Dryden*
28. ***Lawrence Whitcomb, cooperator***
29. *P. Honess (sp?)*
30. *Emil Williams*
31.
32. ***Ralph W. Stone, staff***
33.
34. ***Richard E. Sherrill, cooperator***
35. *R. C. Tucker*
36.
37. *P. H. Price*
38. ***Benjamin L. Miller, cooperator***
39. ***Eleanora Bliss Knopf, cooperator***
40. ***Anna Jonas Stose, cooperator***
41. ***George H. Ashley, staff***
42. ***Bradford Willard, staff***
43. ***Marchant N. Shaffer, staff***
44. ***Forrest Moyer, staff***
45. ***Stanley H. Cathcart, staff***

A scene from the fifth Field Conference of Pennsylvania Geologists in 1935, which took place in the region near Philadelphia, Pa.

NEW STATE GEOLOGIST—Dr. Ralph W. Stone, left, who served an interim appointment as acting state geoogist, turns over his keys to Dr. Carlyle Gray of Penbrook, who has been named to the post. Watching is State Secretary of Internal Affairs William S. Livengood. Dr. Stone was called out of retirement to fill temporarily the position made vacant last March when Stanley H. Cathcart died. —Evening News Photo

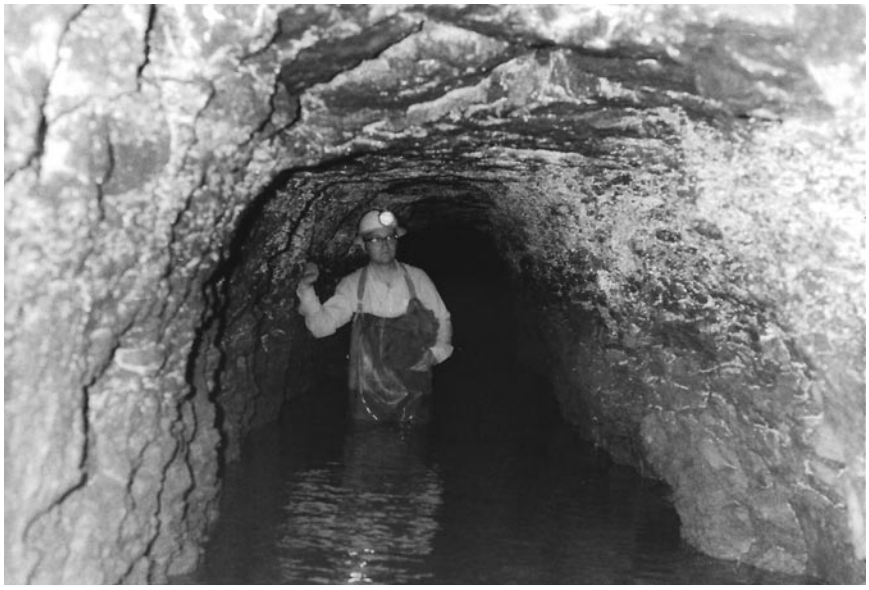
Newspaper clipping from the (Harrisburg) Evening News, October 1, 1953, showing interim State Geologist Ralph Stone handing over the keys to the new State Geologist, Carlyle Gray.

During an open house on March 5, 1957, new employee and paleontologist and future State Geologist Donald Hoskins used a microscope to examine fossils as State Geologist Carlyle Gray and Secretary of Internal Affairs Genevieve Blatt looked on.



A staff field trip in 1958. The people on the upper level are identified left to right as William Lytle, "Smoky" Miller, future State Geologist Arthur Socolow, Davis Lapham, and future State Geologist Donald Hoskins.

Probably in the 1960s, staff geologist Richard Conlin examined a magnetometer that was mounted on an airplane to survey magnetic anomalies.



In the early 1970s, staff economic geochemist Robert C. Smith, II, waded into the abandoned Ecton copper-lead-zinc mine in Montgomery County to examine its complex mineralogy.

Members of the Survey's Field Mapping Division on a staff trip in the 1970s. Back row, left to right: John Way, David MacLachlan, Viktoras Skema, Samuel Root, Thomas Berg, Jon Inners, and Rodger Faill. Front row: William Sevon, Mark Sholes, and Henry Schasse.

State Geologist Arthur Socolow in 1978, holding a Geiger counter while staff economic geochemist Robert Smith collects a sample near Sonestown, Sullivan County, in preparation for the 43th [sic] Field Conference of Pennsylvania Geologists.

Student intern and future State Geologist Jay Parrish sampling the Conestoga Formation in Millersville, Lancaster County, in 1976.

Staff geologist James Shaulis examining newly drilled core in the field in the early 1980s.

Staff geologist David B. MacLachlan leading a field trip in the 1990s.

Staff geologists Gary Fleeger and William Bragonier reorganizing core that was stacked to the ceiling at the Survey's off-site core storage facility in Hollywood, Clearfield County, in the 2000s.

Photograph of most of the Survey staff on the occasion of the 150th anniversary of the First Survey in 1986. Staff geologist Clifford Dodge was the photographer. Harrisburg staff not present when the photo was taken are John Barnes, James Dolimpio, Donald Hoskins, Jon Inners, Thomas McElroy, James Shaulis, and Marjorie Steel. Pittsburgh staff not present are John Harper, Robert Harper, Christopher Laughrey, and John Petro.

1. *Shirley Barner*
2. *Nikki Shatto*
3. *Joseph Kunz (Pittsburgh)*
4. *William Sevon*
5. *David MacLachlan*
6. *Arthur Socolow*
7. *Linda Polk*
8. *Janet Wotring*
9. *Robert Fenton (Pittsburgh)*
10. *Cheryl Cozart (Pittsburgh)*
11. *Mari Barnhart*
12. *Helen Delano (Pittsburgh)*
13. *Denise Royer*
14. *James Phillips*
15. *Lajos Balogh (Pittsburgh)*
16. *Albert Glover*
17. *William Kochanov*
18. *Samuel Berkheiser*
19. *Geary Sarno*
20. *Michael Smith*
21. *Sandra Blust*
22. *Viktoras Skema*
23. *John Kuchinski*
24. *Christine Miles*
25. *Leslie Chubb*
26. *Thomas Berg*
27. *Robert Smith*
28. *John Way*
29. *Leonard Lentz*
30. *Rodger Faill*
31. *Donna Snyder?*

There isn't much that will keep our intrepid staff down. Certainly not a little snow. Here are Thomas Berg, Donald Hoskins, and Samuel Root examining an outcrop in northeastern Pennsylvania in December 1977. To quote geologist Roger Cuffey (Professor Emeritus of Paleontology, The Pennsylvania State University), "A geologist knows no weather."

BUREAU NEWS

From the Stacks . . .

Jody Smale, Librarian
Pennsylvania Geological Survey

The Bureau library continues to add new titles to the collection. Over the last several months, new publications have been added from the American Geosciences Institute, the Geological Society of America, the Mineralogical Society of America, and the National Groundwater Association. Those interested in the mineralogy and mining history of Montgomery County will want to check out Ronald Sloto's new book, a copy of which he generously donated to the library. He has also published books on the mineralogy and mining history of Berks and Chester Counties, which can also be found in the Bureau library. Below is a list of some of the more recent additions to the library's collection.

- ***Directory of geoscience departments (54th ed.)*** / edited by Carolyn Wilson, American Geosciences Institute, 2019.
- ***Earth's early atmosphere and surface environment*** / edited by George H. Shaw, Geological Society of America Special Paper 504, 2014.
- ***High temperature gas-solid reactions in Earth and planetary processes*** / edited by Penelope L. King, Bruce Fegley, Jr., and Terry Seward, Mineralogical Society of America Reviews in Mineralogy and Geochemistry, v. 84, 2018.
- ***The art of finding springs—a translation of L'Art de Découvrir les Sources (2nd ed.)*** / by Abbé Jean-Baptiste Paramelle, translated by Patricia Bobeck, Geological Society of America Special Paper 539, 2019.
- ***The art of water wells—technical and economic considerations for water well siting, design, and installation*** / by Marvin F. Glotfelty, National Groundwater Association Press, 2019.
- ***The mines and minerals of Montgomery County, Pennsylvania*** / by Ronald A. Sloto, [Ronald A. Sloto], 2019.

A Look Back in Time

During the first Field Conference of Pennsylvania Geologists, Charles Butts of the U.S. Geological Survey led a trip to this fossiliferous horizon below the Horseshoe Curve in Blair County. This photograph was taken on May 30, 1931, by former State Geologist (from 1919–46) George Ashley.

To see more photographs from the Bureau's archives, please visit the library's Historical Photographs Collection page.

RECENT PUBLICATION

Progress Report **(October 2019)**

- Bedrock-Topographic and Drift-Thickness Map of the Harlansburg 7.5-Minute Quadrangle, Butler, Lawrence, and Mercer Counties, Pennsylvania (ZIP)

Calling All Authors

Articles pertaining to the geology of Pennsylvania are enthusiastically invited.

Pennsylvania Geology is a journal intended for a wide audience, primarily within Pennsylvania, but including many out-of-state readers interested in Pennsylvania's geology, topography, and associated earth science topics. Authors should keep this type of audience in mind when preparing articles.

Feature Articles: All feature articles should be timely, lively, interesting, and well illustrated. The length of a feature article is ideally 5 to 7 pages, including illustrations. Line drawings should be submitted as CorelDraw (v. 9 or above) or Adobe Illustrator (v. 8 or above) files.

Earth Science Teachers' Corner: Articles pertaining to available educational materials, classroom exercises, book reviews, and other geologic topics of interest to earth science educators should be 1 to 2 pages in length and should include illustrations where possible.

Announcements: Announcements of major meetings and conferences pertaining to the geology of Pennsylvania, significant awards received by Pennsylvania geologists, and other pertinent news items may be published in each issue. These announcements should be as brief as possible.

Photographs: Photographs should be submitted as separate files and not embedded in the text of the article.

Submittal: Authors may send their article and illustrations as email attachments to RA-pageology@state.pa.us if the file sizes are less than 6 MB. For larger sizes, please submit the files on CD–ROM to the address given below. All submittals should include the author's name, mailing address, telephone number, email address, and the date of submittal.

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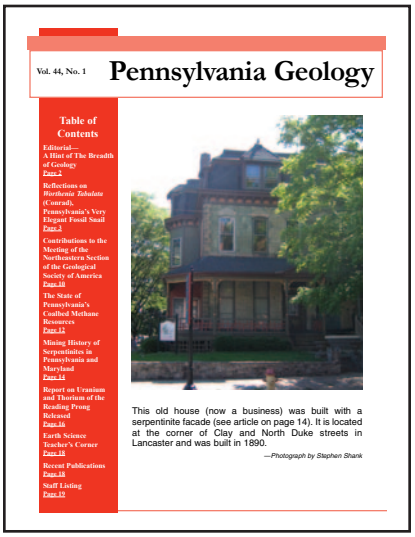
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This old house (now a business) was built with a serpentinite facade (see article on page 14). It is located at the corner of Clay and North Duke streets in Lancaster and was built in 1890.

—Photograph by Stephen Shank

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Contributed articles are welcome.

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