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Ripples and mudcracks in the Ordovician Snyder Formation at the Hanson Brothers Oak Hall quarry near State College, Pa. Serving as scale is David (Duff) Gold, Emeritus Professor of Geology at Penn State.

—Photograph by Charles Miller

EDITORIAL

The Business of the Bureau

George E. W. Love, State Geologist
Pennsylvania Geological Survey

I have been asked, now that there is a new administration in place, if the Bureau of Topographic and Geologic Survey will change the way it does business. Frankly, the question surprises me, because I do not see the bureau as a political entity that needs to swing to the wishes of one party or the other. And as a matter of fact, I have never received any pressure from either Democrats or Republicans to sway the veracity of the work of the bureau. I have, on a few occasions, received some administrative help, probably deserved, to "focus" on the issue du jour.

What we have received at different times from both parties are questions about what the bureau does, how it meets its mandated mission, and what it can do for the taxpayers. I think that those are responsible questions that everyone should ask. True, sometimes the emphasis could be interpreted as somewhat biased, but don't we all have opinions and preferences? I know I do, and they color the way I move forward toward any goal.

What do I see as the role and the focus of the bureau, and will they change? I want to address the focus first. You bet the focus will change. It had better change! As the needs of our society change, so do the demands for the natural resources that help support those changes. Pennsylvania's early human history encompassed the development of mineral resources such as iron, lead, copper, and other metal ores, clays for bricks and pottery, chromite for paint color, graphite for crucibles, and so on. Right now, Pennsylvania is famous for its limestones and dolomites, aggregates, cement, coals, and of course, its natural gas. So, the attention of the bureau needs to shift, as it certainly has over the years. There is no negative in focusing the existing human resources on a currently popular natural resource. Because many of you are geologists, or are in some way related to the minerals industry, you know that I prefer to think of natural resources in the "minerals" way, rather than the "bugs, trails, and trees" way that is the appropriate keystone of DCNR—the Department of Conservation and Natural Resources.

Regarding the role of the bureau, there will be no change. Our legislatively mandated mission is the following:

> "To serve the citizens of Pennsylvania by collecting, preserving, and disseminating impartial information on the Commonwealth's geology, geologic resources, and topography in order to contribute to the understanding, wise use, and conservation of its land and included resources."

That says it all. The proverbial "box" we find ourselves in is spacious, comfortable, and allows a wide latitude for creative thinking, forward-looking projects, and the types of work that attract and keep the dedicated, intelligent staff at the Survey.

A word about the larger portion of this issue—the "In Memoriam" articles. Our profession has lost some outstanding figures over the last few months. Each of these geologists touched the lives of many of us; not just us geologists, but us human beings. Please read the articles and realize that the work of these geologists is recognized, appreciated, and remembered by their colleagues. It is a sad day when we lose a friend, but it is a gift to know that their good work as mentors will carry forward.

Mineralogy at the Pennsylvania Geological Survey—1973 Versus Now

John H. Barnes and Robert C. Smith, II[1] (retired)
Pennsylvania Geological Survey

The ability to study mineralogy in the laboratory at the Pennsylvania Geological Survey has had its ups and downs. Things were looking up in the late 1950s and 1960s as the bureau supplemented its optical microscopes by adding XRD (X-ray diffraction) and XRF (X-ray fluorescence) to its laboratories. But there was an unexpected setback in 1972, when the bureau's headquarters were destroyed by flooding caused by tropical storm Agnes (Figure 1). This took place just a few years after

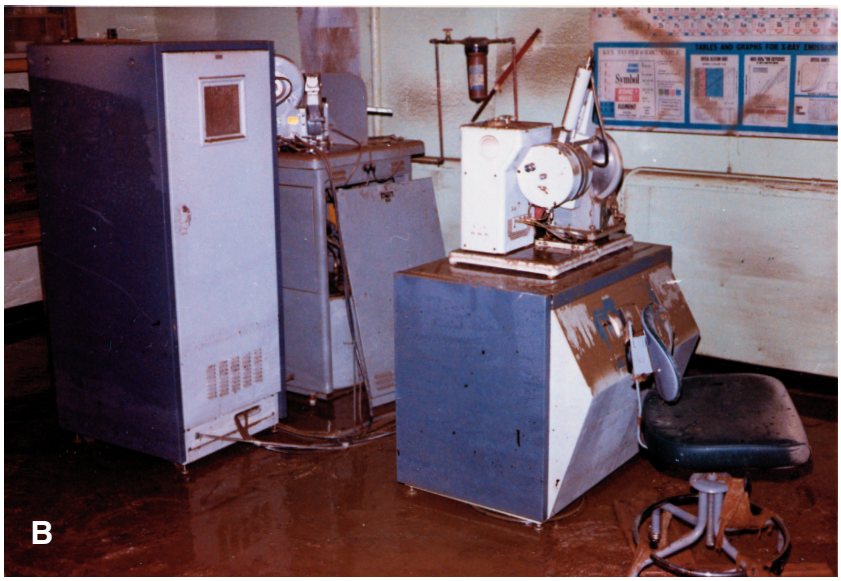

Figure 1. The bureau's X-ray equipment after it was inundated by the floodwaters caused by tropical storm Agnes in June 1972. A. X-ray diffractometer. B. X-ray fluorescence spectrometer.

[1] Mechanicsburg, Pa.

the XRD equipment had been upgraded with new solid-state electronics, and while some additional X-ray equipment was on order but had not yet been delivered.

In 1973, having settled into temporary headquarters that had no lab facilities, the Survey had two surviving Debye-Scherrer cameras for doing XRD work on very small samples (Figure 2), but no source of X-rays. Through the generosity and cooperation of our friends at the Pennsylvania Department of Transportation's former Bureau of Materials, Testing and Research facility, we were able to use their X-ray generator with our cameras, which we loaded with samples and film at our temporary office and took to their laboratory.

Three of the more interesting measurements recorded at that time, among the scores that were obtained, were logged as D73–30, D73–31, and D73–36. The XRD patterns verified acanthite and tetrahedrite from the J. E. Baker Billmeyer quarry in Conoy Township, Lancaster County, near Bainbridge. The geology of this occurrence was documented in Mineral Resource Report 72, *Zinc and Lead Occurrences in Pennsylvania* (Smith, 1977, p. 32–37) (Figure 3). Smith also included a discussion of the mineralogy in the chapter on acanthite in *The Mineralogy of Pennsylvania, 1966–1975* (Smith, 1978, p. 18–19). In a footnote on page 18, Smith noted that despite the XRD data supporting tetrahedrite (the mineral at the antimony [Sb] end of the tetrahedrite-tennantite solid solution series), an XRF scan, run in 1976 on an instrument that had become available after recovery of the bureau's labs from the flood, suggested that the more abundant metallic mineral contained Cu, Fe, Zn, As, and Ag, in approximately decreasing order. This implied that the bulk sample was tennantite, the mineral at the arsenic (As) end of the series. The XRD patterns for tennantite and tetrahedrite are very similar to each other because the respective As and Sb are good fits for one another in the crystal structure, so a misidentification using only XRD data would not have been surprising. Furthermore, whereas the Debye-Scherrer X-ray powder diffraction cameras required less than 0.1 milligram of material, the XRF equipment in use at the time was designed for bulk analyses and typically required a 500-milligram sample. This could result in a mismatch between the samples used for the two different techniques.

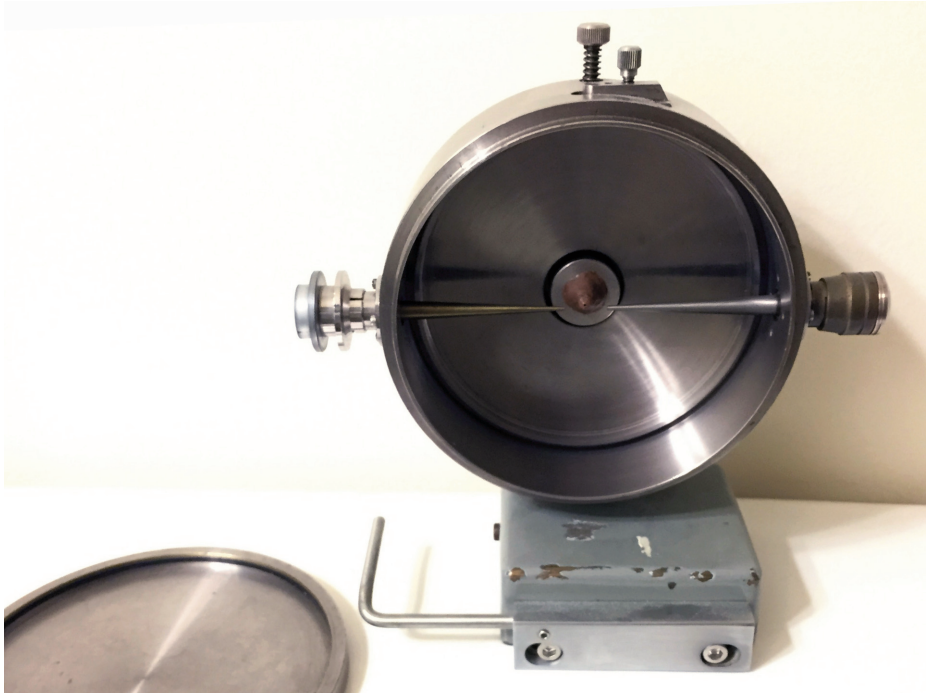

Figure 2. Debye-Scherrer X-ray diffraction camera. The sample was shaped into a rod held together with Duco cement and mounted in the lump of clay in the center of the camera. A strip of X-ray film lined the interior circumference. X-rays entered through the long, cone-shaped collimator on the left and were diffracted by the sample, making lines on the film that could be measured to determine the identification of the mineral. X-rays that were not diffracted by the sample exited through the cone on the right and were stopped by a fluorescent screen, used for aligning the camera, and a thick piece of lead glass at the end of the cone.

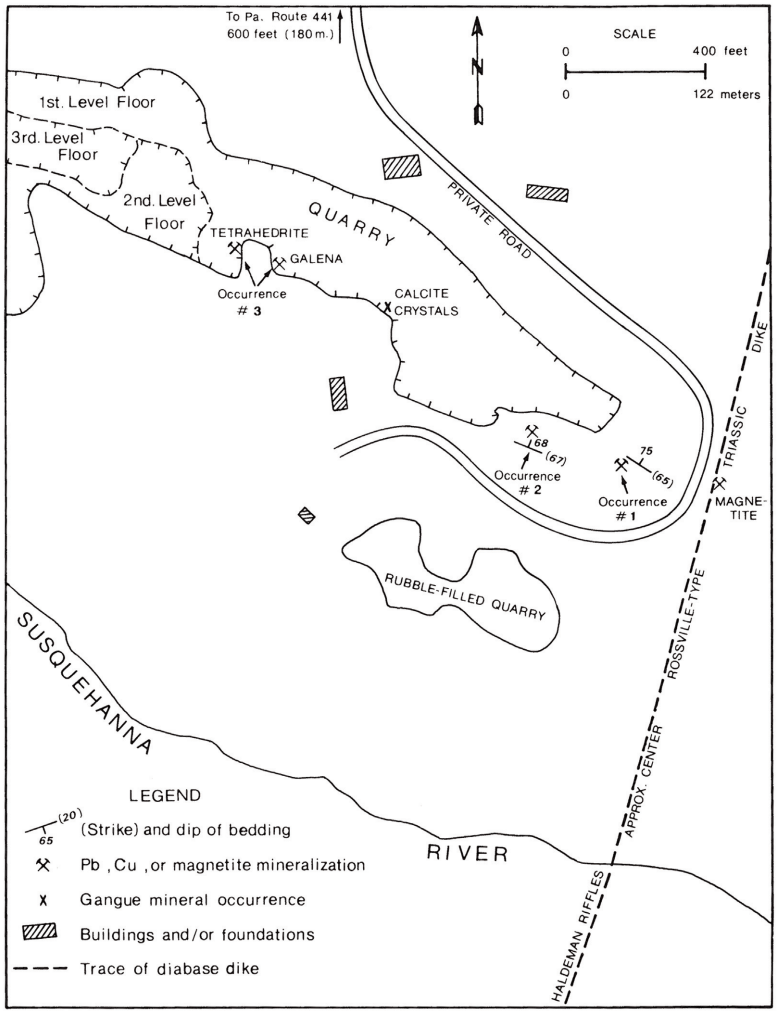

Figure 3. Metallic occurrences and other mineral observations at the Billmeyer quarry, Lancaster County. Location of magnetite and occurrence no. 3 courtesy of L. J. Duersmith (Smith, 1977, p. 34, Fig. 8).

Scroll forward 41 years. The bureau still has XRD (considerably upgraded since 1972) and has replaced the XRF instrument with an SEM (scanning electron microscope) that is equipped for doing EDS (energy dispersive spectrometry) analyses on microscopic samples (Figure 4). Using the SEM/EDS equipment, Smith, now retired but an active volunteer with the bureau, took another try at identifying metallic minerals in a chip of quartz from the Billmeyer quarry. The chip contained a thin veneer of weathered metallic minerals, one of which appeared to be acanthite based on it being extremely sectile (it could be cut) when touched lightly with a needle. He managed to lap down (which means fine grinding done on a horizontal lap) and polish the chip without grinding through the extremely soft acanthite and secondary minerals. As shown in Table 1 and Figure 5, *both* tetrahedrite *and* tennantite were found in the one chip. This analysis not only showed that the original XRD identifications of acanthite and tetrahedrite that were made 41 years ago were correct. It also found that the less abundant tennantite that the old XRF analysis of 1976 indicated was indeed present and, beyond that, it found a mineral that is new for Pennsylvania, freibergite, which is a silver-rich member of the same tetrahedrite group. It was fortunate that a chip from the suite of the samples worked on using XRD in 1973 survived to 2014 to reveal the secrets that it held!

One of the conclusions of this story is how different methods of mineral identification and analysis have their unique advantages and their limitations, which is why we have several methods available to

Figure 4. Panorama of the bureau's present-day analytical laboratory. The X-ray diffractometer is on the left, in the corner, and the scanning electron microscope is on the right.

Table 1. *EDS Analyses of Tennantite, Tetrahedrite, and Freibergite from the Billmeyer Quarry*

(Values are percentages)

Element	Tennantite-tetrahedrite	Tetrahedrite-tennantite	Freibergite
S	24.06	22.70	20.19
Fe	1.37	1.69	5.35
Cu	43.05	39.52	10.73
Zn	7.41	6.68	5.93
As	14.12	5.33	2.46
Ag	.11	.29	35.70
Sb	9.87	23.79	19.64

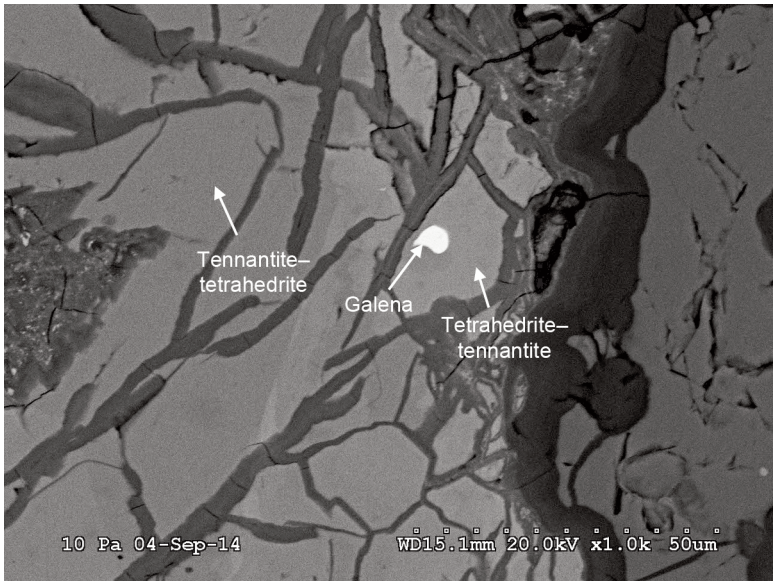

Figure 5. Scanning electron photomicrograph showing the region of the sample from the Billmeyer quarry in which both tennantite and tetrahedrite were identified using energy dispersive spectrometry.

us. The place to start is usually through classic methods that require little equipment other than a trained eye and a few simple tools to recognize properties such as color, hardness, streak, cleavage, and crystal habit. The ability to identify minerals using these properties varies greatly depending on the skill level of the person trying to make the identification, the quality of the specimen, and the person's familiarity with the mineral. For more difficult identifications, for working with fine-grained mixtures of minerals in rocks, or to verify an observation, we turn to instrumentation.

XRD works by measuring the distances between layers of atoms in a crystal structure, but it provides no data as to the identity of those atoms. It can be used alone to identify many minerals, but minerals that have very similar structures, such as tennantite and tetrahedrite, can be mistaken for each other when using only this method. XRF and its close cousin, EDS, can identify the chemical elements in the mineral, but provide no information as to how the elements are arranged into a crystal structure. Using only this method, minerals that have the same chemical composition, such as calcite and aragonite (both calcium carbonate), can be mistaken for each other, but they can be easily distinguished from each other by using XRD. Beyond XRD and EDS, specialized polarizing optical microscopes reveal details of how minerals are related to each other, including such information as which formed first and which might have replaced another.

It sometimes takes a small arsenal of techniques and instruments, and some experience using them, to properly identify many minerals.

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IN MEMORIAM

Rodger T. Faill

Rodger T. Faill (Figure 1), Ph.D., deceased December 10, 2014, was a remarkable person and geologist. Six weeks before his death, Rodger was preparing a new geological manuscript. It dealt with the deeply hidden causes for the anticlinal structures that form most of the topographic ridges of Pennsylvania's Appalachian Mountains. Some of Rodger's last geological words, dated Wednesday, October 1, 2014, were in a handwritten paper entitled *Reverse Sequence Outline,* and were as follows: "Changes in the anticlinal wave length were minimal from Plateau to V&R [Valley and Ridge] and occurred from basal decoll [décollement] in the Cambrian. Supra salt structures on anticlinal crests were a consequence of salt tectonics, building atop underlying low amplitude anticlines …"

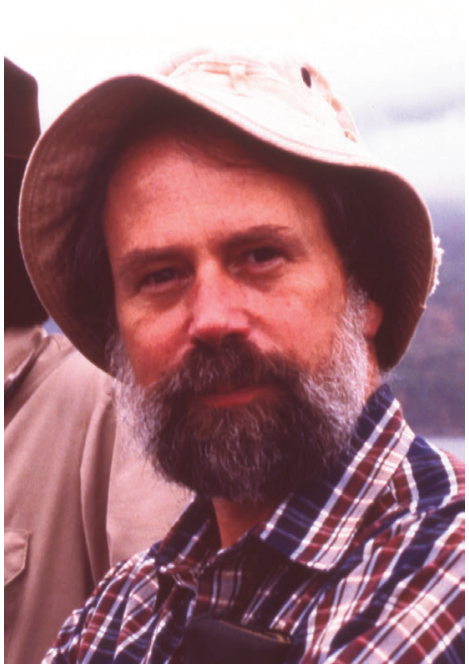

Figure 1. Rodger T. Faill in 1986. Photograph by Clifford Dodge.

Rodger's family recalls that, while sitting in a class taught by Professor John Imbrie of Columbia University, he decided to become a geologist. Rodger had graduated with a bachelor's degree from Princeton University in 1958, and then matriculated at Columbia University's Lamont-Doherty Earth Observatory, where he earned the following degrees in geology: B.S. (1962), M.S. (1963), and Ph.D. (1966).

Rodger found employment in September 1965 with the Pennsylvania Geological Survey and provided Pennsylvania with 42 years of exemplary public service, retiring in 2007. At the bureau, he was predominantly a field geologist with a focus on structural geology, and he produced, some collegially with coauthors, numerous geologic maps and reports, at 7.5-minute topographic quadrangle scale, of Pennsylvania's Ridge and Valley province. Notable among his many reports published by the bureau was Atlas 136, *Geology and Mineral Resources of the Millerstown Quadrangle.* While doing field work for this quadrangle, he first encountered a style of folds that did not fit the commonly accepted concentric model for describing folds in the Ridge and Valley. Recognizing that the model was faulty and needed to be replaced, Rodger submitted two manuscripts that were published by the Geological Society of America in 1969 and 1973, in which he described and explained an accurate fold model of kink bands at all scales (Figure 2).

For still other mapping projects, colleagues sought his advice to confirm or to provide alternatives to what other field geologists thought they were seeing. As late as spring of 2013, Rodger assisted colleagues in examining the glaciogenic Rockwell Formation of Maryland and West Virginia, where the stratigraphic section at Pearre, Md., made more sense after Rodger recognized a fault near the west end.

Because of Rodger's mapping along the Allegheny Front in the Tyrone area of Blair County, he encountered and interpreted the enigmatic Tipton block, a triangular-shaped downdropped block bounded by strike-slip faults. The Tipton block, two similar, smaller, adjacent blocks, and a concentration of northwest-southeast strike-slip faults to the north of the Tipton block form a unique area of extension along the Allegheny Front at a point where the orientation of the Front changes from a

Figure 2. One of Rodger's favorite exposures for the in-between scale of kink bands was at the Lewistown Reservoir, Mifflin County. He led conferees at the 1973 Field Conference of Pennsylvania Geologists to this exposure. Photograph by Gary Fleeger.

more southerly trend to the south of the block, to a more easterly trend to the north and east. The Tipton block was thrust to the northwest, into and beneath Plateau rocks. Other geologists had mapped some of the faults of the complex. But Rodger did more than map areas. He developed interpretations of the geologic history of the areas that he mapped, leading to a much better understanding of the history of the central Appalachians.

As it was with the kink-band model, Rodger also examined the Mesozoic rocks of Pennsylvania in the Gettysburg and Newark basins. He noted the significance of Paleozoic bedrock exposures well out into these basins, which did not fit well the then-prevailing graben model or even the transitional half-graben model. Further, he pointed out the difficulty of maintaining water in the various saline lakes of the Newark basin if the northwest margin were repeatedly being downdropped at a major border fault during deposition of sediments. Though many apparently still do not accept it, his model of post-depositional tilting, downwarping, faulting, and folding warrants consideration by all who study these rocks.

Likewise, he recognized that the interpretation of separated depositional Mesozoic basins that were present from central Virginia through Maryland, Pennsylvania, and New Jersey into New York was incorrect. His analysis of their sedimentology and structure resulted in the recognition that they were erosional remnants of a single depositional basin he newly named the Birdsboro basin (Faill, 2003). As was sometimes the case with Rodger's iconoclastic approach to reexamining long accepted geological models, his interpretations drew its detractors (Schlische and Withjack, 2005). In Rodger's classic reply (Faill, 2005), he acknowledged that 99 percent of the geologic community disagreed with him.

As evidenced by his work with kink-band folding and Mesozoic basin development, Rodger was somewhat of a maverick who commonly seemed to look at geology in different ways than most of his predecessors. His observational skills, creativity, and unique way of looking at things allowed him to develop new ideas. Not everyone accepted Rodger's new interpretations, but he inspired thinking

outside the box and generated much discussion, which commonly resulted in a much better understanding of Appalachian geology.

In addition to kink-band folding and Triassic basin development, other creative significant ideas proposed by Rodger included the following:

(1) The propagation of Alleghany deformation from the Allegheny Plateau to the southeast, the reverse of the generally accepted premise. He appeared to have been working on this idea again at the time of his death.

(2) An alternative to the Peach Bottom syncline interpretation in the Pennsylvania Piedmont.

Rodger's interests were not restricted to the Ridge and Valley, but included all of Pennsylvania as well as much of the Appalachian Mountain province of North America. In a draft manuscript that he submitted to the bureau in the 1990s, Rodger summarized the history of the north-central Appalachians from the earliest known orogeny of the Mesoproterozoic through the Taconic, ending with the Alleghany orogeny. On review, recognizing that his manuscript deserved a fuller audience, the bureau recommended that it be nationally published. It was published by the *American Journal of Science* in three separate papers, all of which have been widely cited by many authors.

Rodger authored or coauthored two chapters in the *Geology of Pennsylvania,* published in 1999. Rodger was senior author, with Dick Nickelsen of Bucknell University, of the chapter on the structural geology and tectonics of the Appalachian Mountain section of the Ridge and Valley province. He was the sole author of the chapter on the geologic history of the Paleozoic Era. Better authors for those 2 chapters could not have been found.

Two of Rodger's last Pennsylvania Geological Survey publications were the *Earthquake Catalog and Epicenter Map of Pennsylvania* and *Folds of Pennsylvania—GIS Data and Map.* Both were extensive compilations of data from various sources and were representative of Rodger's interest in structural geology and tectonics.

In 1992, Rodger became Chief of the Eastern Mapping Section (in the Geologic Mapping Division), where he supervised two to three geologists working largely in the Ridge and Valley and Piedmont provinces (Figure 3). He held the position of Geologist Supervisor until his retirement in 2007. In 2001 and 2002, he also supervised and coordinated the activities of the Survey's Coal Availability Program, in cooperation with the U.S. Geological Survey, which involved at various times up to 11 geologists and resulted in five publications summarizing estimates of bituminous coal resources available for mining in five selected quadrangles.

Figure 3. Rodger as Chief of the Eastern Mapping Section in 1996. Photograph by William Kochanov.

In addition to being a member of the Geological Society of America (a Fellow since 1978) and the Society of the Sigma Xi, Rodger was a member of the Field Conference of Pennsylvania Geologists. He was the principal leader for several of the annual Field Conference trips, where he was a mentor to students and fellow colleagues alike with his explanations and field demonstrations of his interpretations. Rodger led (Figure 4) or contributed to six Field Conferences between 1973 and 2008. As was to be expected because of his extensive geological knowledge across the state, he contributed to Field Conferences in the Allegheny Plateau, Ridge and Valley, Mesozoic basin, and Piedmont Upland.

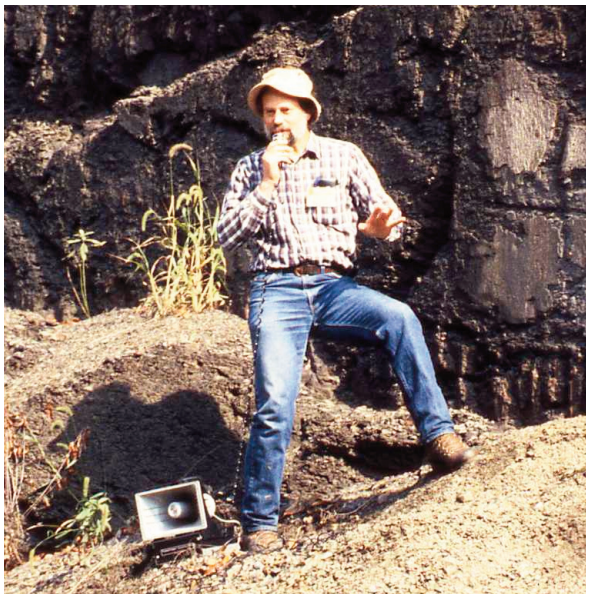

Figure 4. Rodger leading the discussion at a stop at the 1990 Field Conference of Pennsylvania Geologists. Photograph from Pennsylvania Geological Survey files.

Rodger had many interests and well served his community. Enjoying classical music, Rodger was host for the early morning FM radio (the former WMSP) broadcast "Sleepers Awake" from Harrisburg's Market Square Presbyterian Church. He also supported his residence community by serving as the chairman of their Shade Tree Commission and as Judge of Elections. He was also, for a time, involved with the Harrisburg Community Theater.

We shall sorely miss his collegiality and his ability to see geology as it is when examined as deeply and carefully as he did. He set a standard for all to follow who seek to interpret the complex geology of the Appalachians (Figure 5).

This memorial was prepared by present and former staff members of the Pennsylvania Geological Survey.

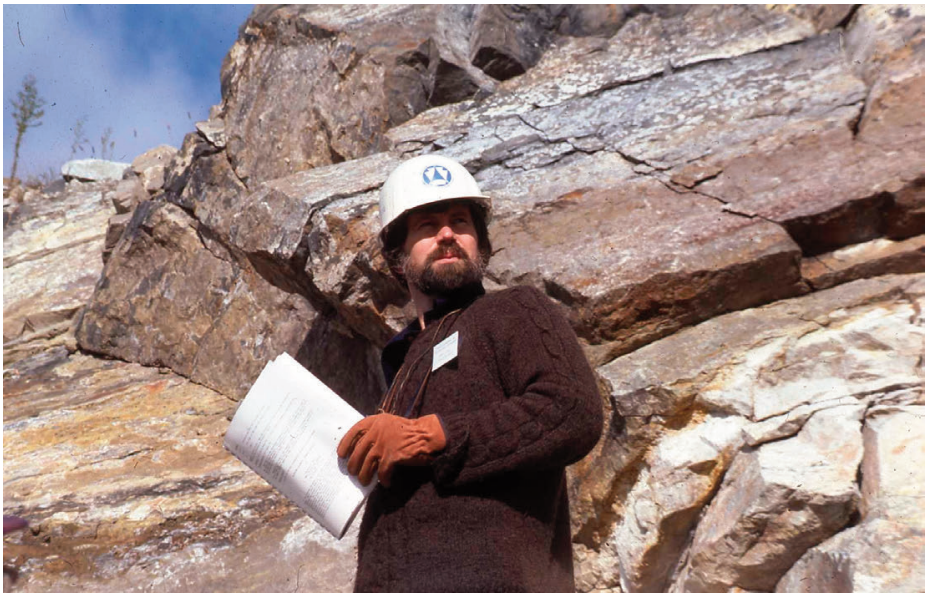

Figure 5. Rodger T. Faill. Photograph from Pennsylvania Geological Survey files.

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IN MEMORIAM

Albert D. Glover—A Remembrance

Clifford H. Dodge
Pennsylvania Geological Survey

The Pennsylvania Geological Survey lost a dear friend, colleague, mentor, and career staff member (retired) with the recent death of Albert "Al" D. Glover on November 25, 2014 (Figure 1). Al was a resident of Bethany Village, Mechanicsburg, Pa., and formerly lived in Camp Hill. He was 86 years old and had been in declining health for several years. Al will best be remembered for his contributions and enthusiastic devotion to the science of geology, particularly bituminous coal, and equally noteworthy, for his intelligence, warm, gentle personality, boundless generosity, great sense of humor (sometimes self-deprecating), and deep religious faith. He strongly believed in fairness and happiness.

Figure 1. Albert "Al" D. Glover (1993).

Background

Albert Douglas Glover was born on August 24, 1928, in Starrucca, Wayne County, in the northeastern corner of Pennsylvania. He was the son of the late Albert John Glover and Lillian Glover (née Neild), who, along with his late uncle, Horace S. Glover, owned the Glover Brothers Dairy Farm in Starrucca. Al was the oldest of six siblings, consisting of four brothers and two sisters (Figure 2). For many years within his family circle, he was commonly called Doug or Douglas to distinguish him from his father Albert.

Figure 2. Al Glover as a child growing up in Starrucca (early 1930s). Photograph provided by Glover family.

Growing up on a dairy farm was hard work, with long hours and seemingly endless chores and responsibilities. Al would recall the tough times making ends meet during the Great Depression and ensuing years of the United States' involvement in World War II. He quickly learned the challenges and creativity of making do with what you have during an extended period of restrictions and rationing. Al was especially fond of describing the thankless task of keeping the family car, a Hupmobile, operating at a time when replacement parts and tires were scarce or unavailable (the tires literally had patches on the patches). Nevertheless, he and his family realized that they were relatively better off than many others who lived in the cities and did not have the same access to fresh dairy products and other farm produce.

Rod Glover, Al's older son, remembered learning about his father's life on the farm from Al's brother, Roger (Rodney D. Glover, written communication, 2015):

> "As for farm stories, I recall hearing from Roger that [my father] was always a jokester, but that being the oldest, he was quite 'authoritative' with his younger brothers. [Roger] recalled the cutting of ice on the ponds

in winter and the blocks being hauled with horse and wagon to the icehouse where they were packed in sawdust (there was a sawmill in town). [My father] was the one who convinced my grandfather to install the first shower in the main bathroom of the farmhouse to everyone's great excitement, and he was the one who my grandmother relied on to secure the chicken from the coop for dinner. [Roger] sometimes said he could hear her call, 'Douglas, get me a chicken!' "

Education

The Glover family stressed the importance of education, for which Al showed great aptitude. He attended Starrucca School, a three-year high school, and graduated in 1945 as both valedictorian and class president. He then went on to a fourth year of high school at nearby Thompson High School in Thompson, Susquehanna County, where he joined the baseball team that subsequently won the county championship.

After completing his secondary school education, Al returned to the family farm and worked there for the next eight years. Feeling compelled to do more with his life, he volunteered for military service and joined the Army in April 1954. Al was stationed at Camp Gordon (now Fort Gordon), Augusta, Ga., where he put his typing skills to use, securing a position as Personnel Specialist in the Signal Corps. It was during this time that Al learned some important lessons, such as the practical limits of volunteering. One day, for example, his sergeant had all the men line up in the barracks and asked for a volunteer to do some unpleasant, laborious task under the hot Georgia sun. Al and most of his comrades immediately took a large step backwards, leaving a few stragglers out in front from whom the sergeant quickly chose his "volunteer"! Al was honorably discharged in January 1956.

It was his time in the Army and contact with many people of varied backgrounds, some college educated, that made Al secure in his abilities and influenced his decision to further his education. He was also motivated by the new education benefits available to him through the Korean War G.I. Bill. In the autumn of 1956, Al became the first of his siblings to enroll in college, attending Harpur College, State University of New York (SUNY) (now Harpur College of Arts and Sciences within SUNY at Binghamton). Al majored in geology and graduated with a B.A. degree in June 1960 (Figure 3). His initial interest in geology may have stemmed from his general love of nature and the outdoors, but he was no doubt further inspired by some of his geology professors. He also showed a particular interest in coal, which was in common use throughout the country during his youth for domestic heating and cooking, manufacturing, steam generation, and steel making. Furthermore, coal was well known and valued as a significant economic resource where it was mined nearby to the south in the Northern Anthracite coalfield.

Figure 3. Newly minted college graduate (1960). Photograph provided by Glover family.

Toward the end of the summer following college, Al married his sweetheart Mildred, or "Milly" (née Bailey), of Endicott, N.Y., on September 3, 1960. Shortly thereafter, he began graduate studies, enrolling in the Geology Department of the University of Illinois at Urbana–Champaign because of its reputation in coal geology. During the next two years, Al completed course work and conducted research on his master's thesis topic dealing with the depositional environments of the Trivoli and overlying Carlinville cyclothems and their equivalents in parts of the Illinois and Western Interior basins. His thesis advisor was the eminent Dr. Harold R. Wanless, noted Pennsylvanian stratigrapher and coal geologist, who was one of the principal architects

of the cyclothemic concept. Al felt inspired by him. While in graduate school, Al worked as a research assistant in the Groundwater and Geophysics (now Hydrogeology and Geophysics) Section of the Illinois State Geological Survey, which was located on the campus of the university. His time as a research assistant cemented his love of geological survey work.

Career

By the spring of 1962, with his wife Milly well into her first pregnancy, Al began looking for full-time employment to support his growing young family. Fortunately, he found success in a short period of time. Al accepted a position with the Pennsylvania Geological Survey in Harrisburg and, in September 1962, began his career as a coal geologist. The location of the Survey office proved to be a bonus, as both Al and Milly had hoped to return to the area to be closer to their families in northeastern Pennsylvania and southern New York and to the mountains and valleys they loved (they found southern Illinois much too flat).

Al's first assignment was to assist staff member Bernard "Buck" J. O'Neil, Jr., with the completion of the *Atlas of Pennsylvania Mineral Resources, Part 1—Limestones and Dolomites of Pennsylvania,* which was published in 1964 (Mineral Resource Report 50, Part 1). Al conducted a literature review of information sources for use in the study and compiled thickness data for the Vanport Limestone distribution map of western Pennsylvania (Map 4 of the report). The Vanport is an economically important high-calcium marine limestone that occurs within the bituminous coal measures of the lower Allegheny Formation (Middle Pennsylvanian).

Next, Al was introduced to the coal geology of Clearfield County in western Pennsylvania by William "Bill" E. Edmunds, head of the informal Coal Section at the bureau. Al briefly worked on Edmunds' northern Houtzdale report (Atlas 85ab) and then was assigned his own geologic atlas study for the southern half of the Clearfield 15-minute quadrangle (Atlas 84cd). Including this investigation, Al eventually authored or coauthored four detailed geologic atlas reports that dealt with the geology and mineral resources (primarily bituminous coal) of several selected quadrangles and principally covered parts of Blair, Cambria, Clearfield, and Jefferson Counties (see the "Selected Bibliography" for Al at the end of this paper). The studies were undertaken at a time of increased coal production by surface mining, renewed exploratory drilling for coal and clay, and expanded road construction (including the new Interstate Highway 80), which provided a wealth of new exposures and subsurface data for accurate geologic mapping. The atlas studies involved extensive fieldwork, requiring Al to be away from home much of the time each year between May and October (Figure 4).

Figure 4. Fieldwork in the Altoona area (1981). Al is denoting the contact (with his right hand) between the Burgoon Sandstone and the overlying Loyalhanna Member of the Mauch Chunk Formation (both Mississippian).

Early in his career, Al found time to complete his thesis work and received his M.S. degree in geology in 1964.

Many other published maps and reports followed, of various kinds, but especially related to cooperative work with the National Coal Resources Data System (NCRDS) of the U.S. Geological Survey (USGS). Al went on to author or coauthor four such Mineral Resource Reports that included maps of coal crop lines, mined-out areas, and structure contours by quadrangle on a countywide basis (Figure 5). He was also heavily involved with bedrock geologic map compilation for the 1980 *Geologic Map of Pennsylvania* (Pennsylvania Geological Survey, Map 1).

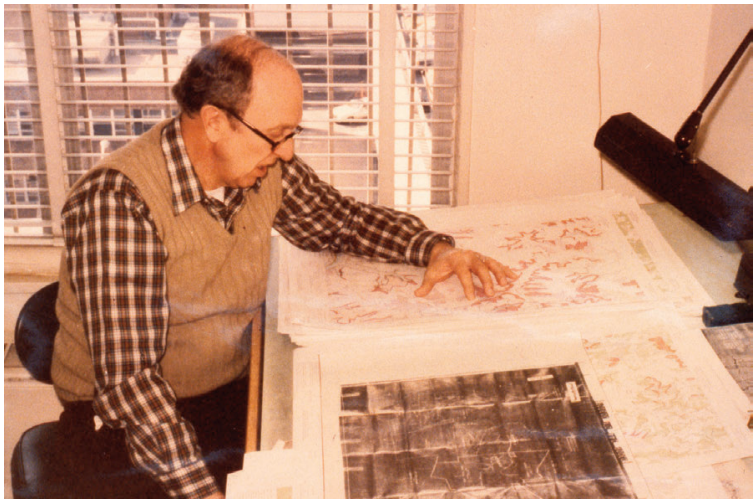

Figure 5. Compiling the extent of known surface and underground coal mines on topographic quadrangle base maps for Clarion County (1986). Photograph from Pennsylvania Geological Survey files.

With the resignation of Bill Edmunds, Al was appointed head of the Coal Section (informal) of the Geologic Mapping Division in August 1977. In this role, he was responsible for the overall planning, organization, and direction of a comprehensive program of investigations on the coal resources and associated geology in western Pennsylvania (i.e., NCRDS) (Figure 6).

In early 1986, the Coal Section was formalized, and Al was promoted to Geologic Supervisor in charge of up to five coal geologists. His duties and responsibilities now included planning and monitoring coal projects, preparing and implementing exploratory drilling contracts to aid in geologic mapping, reviewing completed maps and reports, preparing performance standards, and evaluating the performance of the coal staff in accordance with departmental procedures. He also provided geologic advice and assistance to bureau staff; other agencies in local, state, and federal government; the coal industry and other energy sectors; consultants; and private individuals. In addition, Al routinely provided expert testimony on matters of geology at hearings and legal proceedings, and represented the departmental secretary on the State Mining Board. He was the Survey's official liaison to the USGS Coal Branch for cooperative coal geology projects with the USGS. He was responsible for reviewing the progress of the cooperative coal work and for preparing required cooperative reports that were then forwarded to the State Geologist for

Figure 6. Exploratory drilling program for coal. Al (right) is supervising core drilling and geophysical logging of a Pennsylvania Geological Survey borehole on Round Knob, Saxton 7.5-minute quadrangle, Bedford County, Broad Top coalfield (1984).

approval prior to submittal to the USGS. Despite his supervisory duties, Al kept up with his various geologic projects on coal.

Al continued in the same capacity after the Coal Section was renamed the Western Regional Section in 1991 to better reflect the expanded role of the section to undertake comprehensive areal geologic investigations in western Pennsylvania that were not limited to coal.

Al officially retired from the Pennsylvania Geological Survey in 1996 after nearly 34 years of dedicated service to the citizens of the Commonwealth of Pennsylvania. Yet he continued to work as a volunteer for an additional five years until the Survey moved to its present location near Middletown. During that time, he completed the coal-resource maps for Armstrong and Jefferson Counties, which remain to be published.

Personality and Traits

Al was noted for his intelligence, friendliness, sense of humor, generosity, thrift, and patience. He was a devoted family man to his wife, two sons, parents, siblings, and other relatives. He enjoyed helping others and working hard, both physically and mentally. It was not uncommon for him to visit his family in Starrucca, climb onto the tractor, and spend the day plowing fields. Retired staff member Viktoras "Vik" W. Skema recalled an occasion when he needed help putting in a pad for a new shed, and Al gladly came over to Vik's home to help pour concrete. Al handled drudgery work remarkably well. He would sometimes spend days at a time proofing computer printouts of geologic data entry without complaint, even taking such work home to complete it to meet a tight deadline. He was always patient and willing to mentor younger staff members and student interns, both in the office and field, training them on how to describe, sample, correlate, and map coals and other rock units according to bureau protocols and standards. He was inquisitive and believed in lifelong learning, once taking a course in bricklaying so that he could rebuild his fireplace with confidence. Al loved to joke and tell stories, using all sorts of gestures, facial expressions, and mannerisms, which made staff members and others alike practically cry with laughter.

In 1986, Al had a chance to showcase his acting talents when he performed in a reenactment of the pioneer work of the First Geological Survey of Pennsylvania (1836–58) at Pulpit Rocks, Huntingdon County. He portrayed our first State Geologist, Henry Darwin Rogers, to the delight of the audience during the sesquicentennial celebration commemorating the establishment of the First Survey, which was hosted by the 51st Annual Field Conference of Pennsylvania Geologists (Figure 7).

Al's thriftiness was "legendary," the result of growing up during the Great Depression. He rode the bus every day to and from work, not interested in the convenience or flexibility of car driving. Indeed, the primary reason he stopped doing volunteer work at the Survey after its move to the Middletown area was the lack of convenient bus transportation. Early in Al's career, daily food and lodging allowances (per diem) for fieldwork were minuscule by today's standards. Before going out in the field for the week, he would prepare all of his lunches, which generally included five peanut butter and jelly sandwiches—one for each day. Al would remark that by Friday the jelly had "bled" through the bread and started to crystallize; nevertheless, the sandwiches required no refrigeration, as none was available, and the last one tasted as good as the first! He would describe the search for inexpensive lodging; once found and the best rooms determined, he and his coworkers would book ahead for the entire field season. Likewise, cheap restaurants were a must, and when a particularly inexpensive and tasty menu item was discovered, such as meat loaf, Al was prone to ordering it from the same venue every day.

Figure 7. Pennsylvania Geological Survey staff as reenactors commemorating the establishment of the First Pennsylvania Geological Survey during its 150th anniversary celebration (1986). Al Glover (seated), with (left to right) John Harper (retired), Bill Kochanov, Jim Shaulis, and Bill Sevon (retired).

Al showed much respect and patience when dealing with the public and their need for geologic information. However, in some instances, he was not above teasing them when they expected too much. For example, a telephone caller would occasionally ask him about some coal matter pertaining to an obscure tract somewhere in Pennsylvania and expect him to know the geographic location and answer to the question off the top of his head. Al would reply with a laugh that about one third or 15,000 square miles of the state is covered with coal and that he, even with his advanced age and experience, could not be expected to know all the answers right away. Similarly, there was a time when the Pennsylvania Department of Aging had a telephone number for information inquiries that was one digit off from Al's office phone, but the digit in question was the fifth one in from right side of the number—meaning that the two telephone numbers differed by 10,000. When a caller for Aging misdialed, Al would explain the error and provide the correct number. However, once in a while, a frustrated caller would misdial the number a second or even third time. At this point, Al would calmly ask the individual how he could have misdialed the phone number so badly as to be off by 10,000! The perplexed caller was usually left speechless, never to be heard from again.

Epitaph

In his condolence message to the Glover family, Thomas "Tom" M. Berg, Emeritus State Geologist of Ohio and former Manager of the Geologic Mapping Division of the Pennsylvania Geological Survey, aptly summarized Al's career as follows (Thomas M. Berg, written communication, 2014):

> "Al Glover was one of the true 'giants' of Pennsylvania's geology! He worked with enthusiasm and dedication, mapping the coal seams and geology of the bituminous coal fields. Al applied his broad understanding of sedimentology, stratigraphy, and structural geology to all the mapping projects he took on. All those projects and Al's publications will stand as monuments to his dedication and devotion to the needs of the people of Pennsylvania. His work provides the three-dimensional geologic framework needed to assess the energy resources, ground water, industrial minerals, and geologic hazards of western Pennsylvania. In all the years of his research and mapping, Al remained jovial, warm, and gregarious. He had a tremendous sense of humor. The citizens of Pennsylvania owe a tremendous debt of gratitude to Al Glover!"

Al was a member of both the Geological Society of America and SEPM (Society for Sedimentary Geology). He was a Registered Professional Geologist in Pennsylvania. He was a 50-year member of the Camp Hill United Methodist Church; a 50-year member of the Lowther Manor Lodge no. 781 F. & A.M., Camp Hill; a member of the Harrisburg Consistory Scottish Rite; and a member and past

president of the Keystonians, a Harrisburg social group promoting Pennsylvania history.

In retirement (Figure 8), Al continued to be active in the organizations he loved. Furthermore, he took up family genealogical research, re-enrolled at Arthur Murray Dance Studio to improve his ballroom dancing (he had previously taken dance lessons before joining the Army), and strongly supported the Harrisburg Symphony Orchestra, rarely missing a performance.

Al was preceded in death by his wife Milly in 2003, and one brother. He is survived by his two sons, Rodney (and partner Thomas Mayes) of Washington, D.C., and Christopher (and wife Susan, née Cobaugh) of Lewisberry; two granddaughters; two brothers; two sisters; and numerous nieces and nephews.

Al will be sorely missed.

Figure 8. Milly and Al Glover in retirement (1996). Photograph provided by Glover family.

Acknowledgments

I especially wish to thank Rod Glover for our lively email exchange, in which we shared many thoughts and recollections about his father. I also appreciate the valuable comments (reminiscences) made by fellow staff members of the Pennsylvania Geological Survey—Bill Bragonier (retired), Jim Shaulis, and Vik Skema (retired)—all of whom, in addition to myself, were good friends of Al. Gary Fleeger kindly reviewed the manuscript.

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IN MEMORIAM

Richard P. Nickelsen

Gary M. Fleeger
Pennsylvania Geological Survey

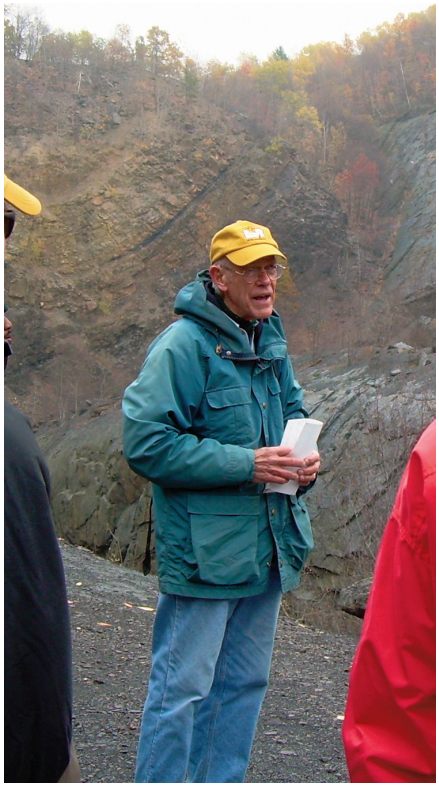


Figure 1. Nick leading a Pennsylvania Geological Survey staff field trip to Bear Valley in November 2007.

On November 23, 2014, the geology world lost an outstanding geologist when Dr. Richard P. Nickelsen (Figure 1), Professor Emeritus at Bucknell University, passed away. Nick was my structural geology professor and also my senior thesis advisor at Bucknell in the mid 1970s. As a young, impressionable geology student, I thought that he was one of the best geologists anywhere. Forty years later, I still believe that. He had exceptional observational and analytical skills that allowed him to unravel very complex structures.

Nick received his bachelor's degree at Dartmouth, and his master's and doctorate at Johns Hopkins, where he worked under the tutelage of the world-famous Ernst Cloos and mapped the Blue Ridge near Harpers Ferry, W. Va. After graduation, he taught at Penn State, but he then decided that he preferred a smaller school where there was more emphasis on teaching. In 1959, he went to Bucknell, where he started the geology department. In keeping with his priority of teaching, he hired Ed Cotter and Jack Allen a few years later, and for several decades, the three of them were the Geology department (Figure 2) (a joint department with Geography for many years), with one or two others joining them for a short time. Nick served as the department chair for more than half of that time. The Bucknell geology curriculum was very field oriented, so much so that when I entered graduate school in 1977, my committee felt that I would gain no more field experience at field camp than I did at Bucknell. I recall taking Nick's structural geology class. Prior to each exam, he made all previous exams that he had given over the years available to us for study. Unfortunately for us, he never repeated a question on his exams.

His dedication to teaching was evident when I was a senior at Bucknell. Nick came out one day that summer to Butler County to spend a day in the field with me, and then drove the four hours back to Lewisburg the same day. Eight hours of driving and many hours in the field was a long, tiring day, but that was the level of support he gave to his students.

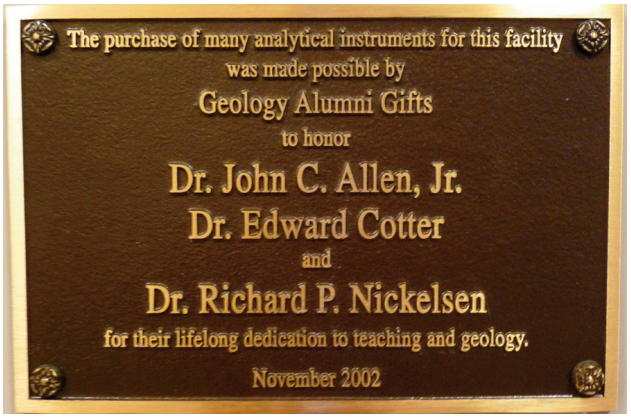


Figure 2. Plaque honoring the original three faculty members in geology at Bucknell. Photograph provided by Department of Geology, Bucknell University.

While he was at Bucknell, Nick maintained an active research program, commonly involving many students. His work made him as significant to Appalachian geology as his mentor, Ernst Cloos, and also John Rodgers, the famous Appalachian geologist from Yale University. His magnum opus was a 17-year-long complete structural analysis of the Bear Valley strip mine and the Whaleback near Shamokin, Pa., published in the *American Journal of Science* in 1979. In that study, he was able to define, based on crosscutting relationships and orientation analysis, the sequence of the six structural stages during the Alleghany orogeny from pre-folding jointing to fold-related extension resulting in grabens. He also documented stress-axis orientation changes during the orogeny. Bear Valley continues to be an incredible teaching laboratory and is visited by geologists from around the world, who are still learning from Nick's work.

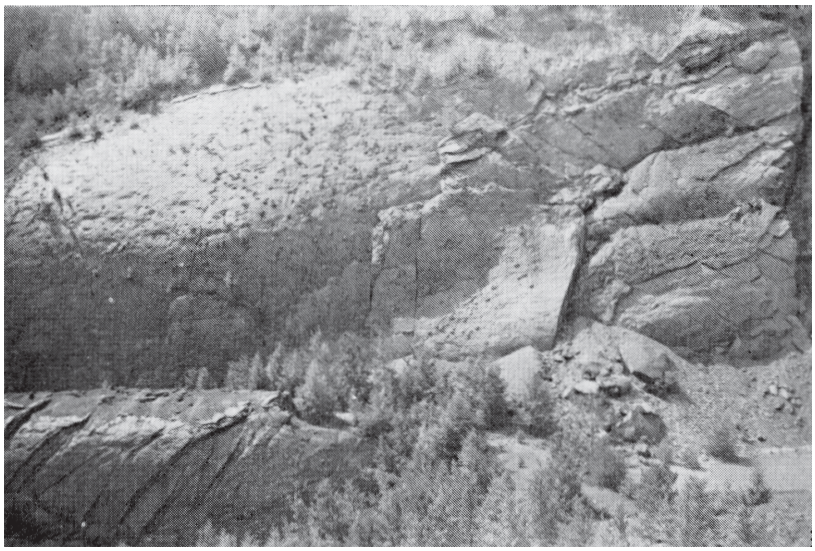
During his later years of teaching at Bucknell, he studied folded thrusts and duplexes in the Seven Mountains region of the Ridge and Valley, leading a Pennsylvania Geological Survey staff trip there in October of 1988. Much of that work was used as a basis for the Field Conference of Pennsylvania Geologists in 2007, led by Tom McElroy (former staff geologist, now deceased) and Don Hoskins (former State Geologist), who were then mapping in the area. Nick was the guest speaker at that year's banquet. The results of his Seven Mountains work appeared in Special Paper 222 of the Geological Society of America (Nickelsen, 1988).

Nick also worked in the western United States and in the Caledonides in his ancestral Norway. There, he made significant contributions to the understanding of the stratigraphy and structure of the Valdres Group, changing the geologic map of Norway.

After Nick's retirement from Bucknell in 1992, he continued to map and research the structural geology of the McConnellsburg area, and he published his final paper in the *Journal of Structural Geology* in 2009 at the age of 84. In that paper, he demonstrated the structural complexity in apparently simple ridges of the Appalachians.

One of his skills that impressed me was Nick's artistic ability to make simple, accurate, detailed, realistic (vs. conceptual) interpretive sketches of complicated outcrops that so clearly illustrated the structures of the exposure in a way that could not be done with photographs. He used these at outcrop scale (Figure 3), hand-sample scale, and thin-section scale. With these sketches, he demonstrated small but significant features that might not otherwise have been apparent on photographs, and might even have been missed in the field by those of us who were less observant. Almost all of his articles and guidebooks contained such sketches. It was also very useful to his students in learning to recognize features in the field.

Nick was concerned with the preservation and enhancement of significant geological sites. Several times, he was involved with preservation attempts at Bear Valley, which continue today, but he was also concerned about any restriction of access that might occur as a result. He also worked with state legislators, the Pennsylvania Geological Survey, and PennDOT (Pennsylvania Department of Transportation) during the planning stages of reconstructing U.S. Route 11/15 between Selinsgrove and Harrisburg. He wanted the road cuts to be designed for easy and safe study by geologists. This stretch includes significant exposures through the five Susquehanna Water Gaps (a National Natural Landmark) of the strata of central Pennsylvania, including the classic Catskill delta, and structures of the Pennsylvania Ridge and Valley province. They continue to be used extensively for educational and research purposes, and they are visited by many geologists. Nick recognized how important it was that all of these significant exposures be preserved for future geologists.



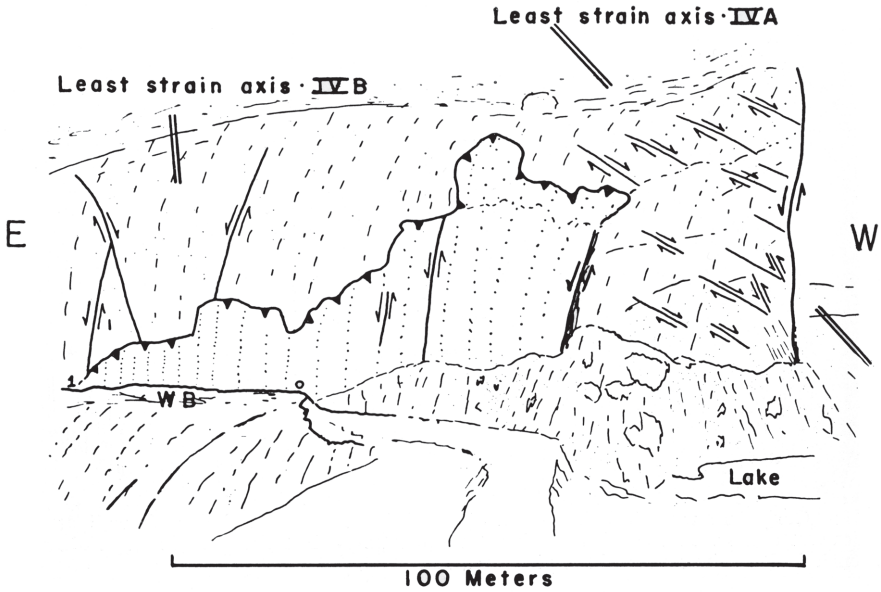


Figure 3. Photograph-sketch pair from Nick's 1979 paper in the American Journal of Science *on the Bear Valley strip mine. Used with permisssion from the* American Journal of Science.

Through the years, Nick always maintained a working relationship with the Pennsylvania Geological Survey, working on a number of projects with various bureau geologists, including Rodger Faill, Don Hoskins, and Bob Smith. Mapping done by students in his field methods and structural geology classes, and senior theses, were always filed at the Survey, and many were used in the compilation of the 1980 state geologic map (*Geologic Map of Pennsylvania,* Pennsylvania Geological Survey, Map 1). He led a number of informal field trips in his research areas for staff members, the last being, appropriately, to Bear Valley in 2007 (Figure 1). At age 82, he still had no trouble negotiating the very difficult terrain of Bear Valley.

Bob C. Smith, II, noted that he had the pleasure of working with Nick on at least three projects. For the first of these, he and John H. Way (former staff geologist, now deceased) worked out the Tioga Ash Beds at Selinsgrove Junction for the 48th Field Conference of Pennsylvania Geologists, led by Nickelsen and Edward Cotter. The second was when Bob assisted with Cambrian-Ordovician carbonate stratigraphy, bentonites, and mineralized faults in Fulton County. While sampling an abandoned limonite mine along the relatively late Cove fault, on the northeast flank of Lowery Knob in Fulton County, Nick suddenly asked Bob to stop hammering. Once it was safe to boost the volume of his personal amplification devices, he pointed to an area to the south from which an unfamiliar birdcall was coming (Nick was an avid birdwatcher, and his original intent was to study ornithology until his hearing loss prevented that course of study), but with a smile he looked directly at Bob when he announced, "an American cuckoo." Nick having a finely honed sense of humor, the comment might have different possible interpretations. The last project involved the Clear Spring olivine melilitite and associated diatreme near the Mason-Dixon line. Nick's special interest in deep faults led to this. Bob had begun detailed mapping of about one ninth of the Clear Spring, Md.-Pa., 7.5-minute quadrangle as a weekend project but lacked confidence in his work. Nick spent several days confirming

Figure 4. Nick leading the 1996 Field Conference of Pennsylvania Geologists.

Bob's mapping, but in the process, Nick also extended the olivine melilitite farther north and recognized a laminated tuff that Bob had completely missed. Nick's mapping abilities covered the gamut of bedrock geology, and his maps commonly included surficial geology.

Nick was very field oriented, and he led countless informal trips, such as the bureau staff trips. He led trips for various public, teacher, and industry groups and organizations. He rarely turned down a request to lead a field trip, where he could share his extensive knowledge.

For many years, Nick was a regular attendee of the annual Field Conference of Pennsylvania Geologists. I accompanied Nick and another Bucknell student on my first Field Conference in 1975, where we actually camped out on boulder colluvium in a cemetery to avoid detection and eviction during the night. Nick also was a periodic leader of the Field Conference, having been leader or co-leader in these years: (1) 1955, which highlighted some of Nick's early work on Plateau coal stratigraphy and structure with Eugene Williams while at Penn State; (2) 1973, on the structure of the Ridge and Valley; (3) 1983 (co-led with Ed Cotter, it holds the record for the largest attendance [278] on a Field Conference trip), which included a visit to the Whaleback at Bear Valley to highlight his years of extensive research there; and (4) 1996, which featured some of his later work on the southwest limb of the Pennsylvania salient in the McConnellsburg area (Figure 4). The 2015 Field Conference, based in Pottsville, will be dedicated to Nick and will include a stop at Bear Valley and the Whaleback.

Nick coauthored, with the late Rodger Faill (Figure 5), the chapter on the structural geology and tectonics of the Appalachian Mountain section of the Ridge and Valley province in the all-encompassing *Geology of Pennsylvania* (Special Publication 1, Pennsylvania Geological Survey). Nick and Rodger were the obvious selections to be the authors of this chapter, the two of them probably having contributed more to the understanding of the structural geology of the Appalachian Mountain section of Pennsylvania than anyone else. With the passing of both of them two and a half weeks apart, a significant amount of knowledge of the topic has suddenly disappeared. As noted by Donald U. Wise (personal communication, December 12, 2014), "Both were among the greats of Appalachian geology and their contributions will be long remembered and cited."

Nick was recognized several times for both his teaching and research contributions.

In honor of his teaching, the following awards were given or established:

(1) The Christian R. and Mary F. Lindback Foundation Award for Distinguished Teaching was given to Nick in 1967.

(2) The Nickelsen Prize for Outstanding Performance in Geology, Bucknell University, an annual graduation prize in honor of R. P. Nickelsen, was established in 1991.

Figure 5. Nick (right) and Rodger Faill contemplating Appalachian structures in 1997. Photograph from Pennsylvania Geological Survey files.

In honor of his scholarship, the following have occurred:

(1) A symposium titled *A Symposium in Honor of Richard P. Nickelsen, "Thrust Belt Structure and Tectonics"* honored Nick at the Southeastern and Northeastern Sections combined meeting of the Geological Society of America in Baltimore, Md., in 1991.

(2) The Career Contribution Award from the Structural Geology and Tectonics Division of The Geological Society of America was given to Nick in 1994.

(3) The *Journal of Structural Geology* published a special issue ("Nickelsen–Groshong volume—Low Temperature Deformation Mechanisms and Their Interpretation," Engelder, Terry, Ferrill, D. A., Gray, M. B., and others, eds., v. 31, 2009) in honor of Nick and one of his former students.

A pictorial tribute to Nick and additional biographical information regarding his numerous other nongeological activities can be found at www.facstaff.bucknell.edu/cad022/DrNickPhotosObituaryArticle.pdf.

This memorial includes significant contributions from Mary Beth Gray and Robert C. Smith, II.

Dr. Richard P. Nickelsen Bibliography

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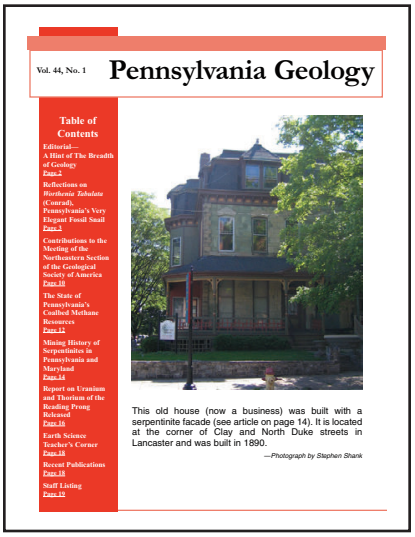
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This old house (now a business) was built with a serpentinite facade (see article on page 14). It is located at the corner of Clay and North Duke streets in Lancaster and was built in 1890.

—Photograph by Stephen Shank

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