

G PENNSYLVANIA O L O G Y



THE PENNSYLVANIA GEOLOGICAL SURVEY

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COMMONWEALTH OF PENNSYLVANIA

Richard L. Thornburgh, Governor

DEPARTMENT OF ENVIRONMENTAL RESOURCES

Clifford L. Jones, Secretary

TOPOGRAPHIC AND GEOLOGICAL SURVEY

Arthur A. Socolow, State Geologist

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ON THE COVER: Blue Rocks Block Field, located two miles north-west of Lenhartsville, Berks County. A narrow, boulder glacier over half mile long; formed by slow, gravity movement of the boulders down the southern slope of Blue Mountain during the glacial climate of the region.

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DECEMBER 1980

FROM THE DESK
OF THE
STATE GEOLOGIST



GEOLOGY, HEADLINES, AND PENNSYLVANIA

Geology and geologic events have in the past couple of decades made the headlines in many ways: as scientific break-throughs with the recognition of the Earth's plate movements; as major-resource traumas with the difficulties of Mid-East oil; as the joyous observation of the astronauts collecting rock specimens on the moon; as the recent tragic Italian earthquake and the awesome eruptions of Mt. St. Helens.

Pennsylvania geology has not had any comparable media events, for which we should probably be thankful. Yet, lest anyone feel that the "arena" of geology in our state is without its episodes and its challenges, let me assure otherwise. From both the standpoint of energy resources and geologic structural interpretation we have the real challenge to determine whether the suggested overthrust belt of eastern Pennsylvania is real or fictional; and if real, is there recoverable oil or gas beneath the thrust sheets. Our Commonwealth energy inventory also carries with it a challenge for geologists to move beyond the numerical calculations of our coal reserves, on to practical determination of composition, depths, and structural conditions which will result in accelerated development of our coal.

Pennsylvania's geologic crises, thankfully not creating human tragedies like recent events elsewhere, are nevertheless, serious, with real economic and personal impacts. The drought in eastern Pennsylvania has had a major effect on the ground-water resources, causing thousands of wells to be depleted and forcing the Delaware River Basin Commission to declare one geologic terrane of the region as a "groundwater-protected area." This poses a challenge to our hydrogeologists to better delineate the groundwater resources of our state, so as to protect the deficient geologic formations and better develop the abundant groundwater areas.

And still on the subject of geologic crises is the continuing need to delineate the landslide areas of western Pennsylvania which annually result in millions of dollars of property damage (see last issue of this bulletin). Of course once we plot all the landslide and sinkhole areas, we hope the officials and decision makers will use the information to protect the public.

Geology, mineral and energy resources, and geologic hazards are daily elements in the lives of all Pennsylvanians. That is sufficient challenge for us to press on with our geologic efforts and responsibilities.

Arthur G. Locolor

Triassic Fossil Reptile Footprints Near Coopersburg, Lehigh County, Pennsylvania

by J. Donald Ryan
Lehigh University

Early in 1978, James Turner, at that time a resident of Bethlehem, PA., noticed a large outcrop of gently dipping red shales in a tractor-trailer parking lot along the east side of Route 309 just south of the village of Coopersburg in Lehigh County. The site is located exactly 0.4 miles south of Station Avenue in Coopersburg and exactly 0.1 miles north of the Lehigh County-Bucks County line (see Figure 1). Much of the soil at the site had been removed exposing bedding planes in the underlying rock. Mr. Turner, an amateur fossil collector who had taken several courses in geology at Dickinson College, could not resist; he pulled over to the side of the road, left his car, and searched for fossils. He found what he thought might be several fossil footprints. Recognizing the potential importance of the prints, he carried specimens to Donald Hoff, curator of the William Penn Museum in Harrisburg, and to the author for confirmation. Both agreed that the specimens indeed were fossil footprints, probably reptilian. The author, who was contacted in September 1978, then suggested that some of the students of Lehigh University might be interested in assisting Mr. Turner in a "dig" at the site to see if additional specimens could be found. A number of students volunteered and spent many hours working on the project. Michael Clinch, Susan Gawarecki, and Steven Perry were particularly active. The group was able to uncover a large number of additional prints in varying sizes, in varying states of preservation. The smallest tracks are 2 - 3 centimeters in length—the largest are 10 - 12 centimeters in length.

In November, Dr. Donald Baird, Director and Curator, Natural History Museum, Princeton University, visited the site and identified at least four types of prints. These are prints of 1) the three-toed prosauropod dinosaur *Anchiosauripus* (see Figure 2), 2) the four-toed crocodile-like armored phytosaur *Rutiodon*, 3) *Chirotherium* also a four-toed reptile but of uncertain affinities (possibly a dinosaur "cousin"), and 4) the tiny lizard *Rhyncosauroides brunswickii*, first described by Willard and Ryan from exposures at Kintnersville, Bucks County, Pennsylvania.

Dr. Baird also noted other prints which need further study before identification is possible. There may also be some undescribed prints at the site.

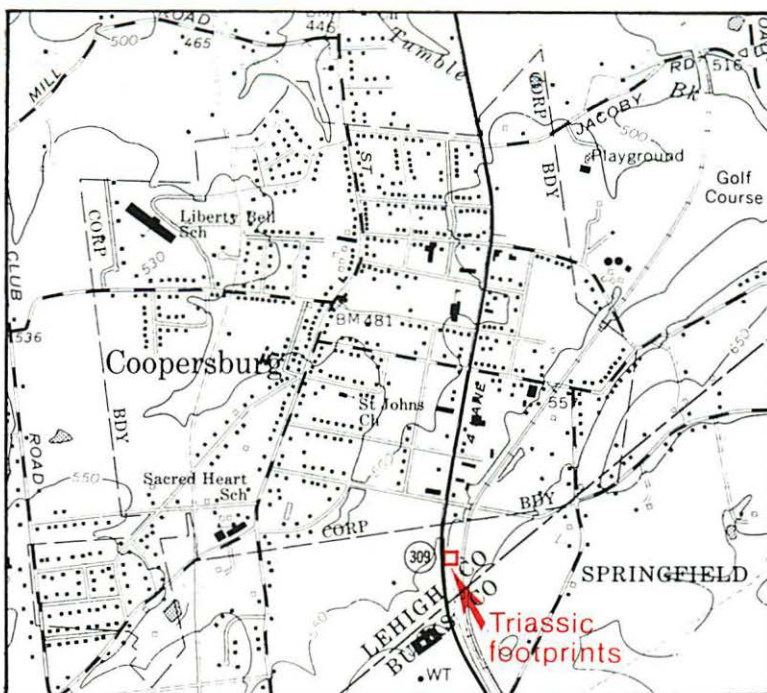


Figure 1. Map showing location of Coopersburg, Pa. Triassic fossil footprint locality. From U.S.G.S. Allentown East 7½' quadrangle.



Figure 2. *Anchiosauripus* footprint in the Brunswick Formation, Coopersburg, Pa. Print outlined with chalk. Length of print about 12 cm.

The tracks occur in red mudstones fairly close to the top (within a few tens of meters) of the Brunswick Formation of the Newark Supergroup a short distance to the southeast of outcrops of the well-known Brunswick fanglomerates which are found along the "Border Fault" (see Wood, et al., 1972, Water Resources of Lehigh County, Pennsylvania, Water Resource Report 31, Pa. Topo. & Geol. Survey). Interestingly, this is at about the same stratigraphic level at which *Rhyncosauroides brunswickii* occurs at the type locality in Kintnersville, Bucks County, along the Delaware River.

In recent years, it has been shown that the Brunswick Formation, traditionally considered to be Upper Triassic in age, is in places partly Jurassic age. The fossil footprint suite at Coopersburg appears to confirm an Upper Triassic age (Rhaetian stage) for the containing rocks at Coopersburg (see Olsen, Paul E., 1980, Triassic and Jurassic Formations of the Newark Basin, in Guidebook, 52nd Annual Meeting of the New York State Geological Association, Warren Manskeizer, editor). The Brunswick Formation outcrops at Coopersburg, therefore, are stratigraphically equivalent to the recently proposed Passaic Formation by Olsen in New Jersey.

groundwater hydrology of the williamsport metropolitan area on open file

A detailed study of the groundwater availability of the greater Williamsport metropolitan area was completed recently by Orville B. Lloyd, Jr. and Louis D. Carswell and is scheduled for publication in mid-1981. The study is based on well records and pump tests of all the rock and unconsolidated aquifers in the area. Both the quantity and quality of the groundwater in each aquifer is discussed. Complete well and spring records and chemical analyses are included. A full-color geologic and hydrologic map of the entire area, as well as a water-table map of the valley-fill deposits, highlight the report. A comprehensive, explanatory legend enables the reader to easily interpret the maps.

This report is now available for inspection prior to publication at the Pennsylvania Geological Survey, Editorial Section, 9th Floor, Executive House, Harrisburg, PA.

MELTWATER EROSION IN SALEM CREEK VALLEY, LUZERNE COUNTY, PENNSYLVANIA

by Jon D. Inners
Pa. Geological Survey

Meltwater channels are the sluiceways that carry off water directly from wasting glacial ice. Generally their courses follow pre-existing stream valleys that slope away from the glacial margin (Embleton and King, 1975). Characteristically such channels (1) show evidence of having once transmitted considerably more water than they presently do, (2) occur within or immediately outside glaciated terrain, and (3) exhibit either extensive waterlaid depositional landforms or striking erosional features. Probably the easiest recognized channels are those that lie directly downstream from either glacial end moraines or recessional moraines. The major control on whether depositional or erosional features dominate is the size of the valley. In wide valleys meltwaters spread out, lose velocity, and deposit their sediment load as gravelly valley trains. In narrow valleys, however, where the meltwaters are concentrated to flow at high velocity, erosion rather than deposition takes place. The volume of water in meltwater channels is subject to great daily and seasonal fluctuations. Not surprisingly, the highest levels are attained during summer days and the lowest on winter nights.

The relationship of terminal ice position to meltwater channels is clearly shown in the vicinity of Berwick, northeastern Pennsylvania (Figure 1). In this area the Woodfordian (Late Wisconsinan) continental glacier reached its maximum extent along an irregular northwest-southeast front that trended diagonally across the North Branch, Susquehanna River, valley between Lee and Nescopeck Mountains. From this advance position the surface of the ice sloped upward toward the northeast at a gradient of about 600 ft/mile near Lee Mountain and 80 ft/mile near Nescopeck Mountain (Inners, 1978; Crowl and Sevon, 1980). Within the area bounded by these two mountains, numerous streams served as sluiceways for meltwater from the glacier. From north to south the most important were Salem Creek on the north side of the Susquehanna, the Susquehanna River itself, and Wapwallopen Creek and two unnamed tributaries of

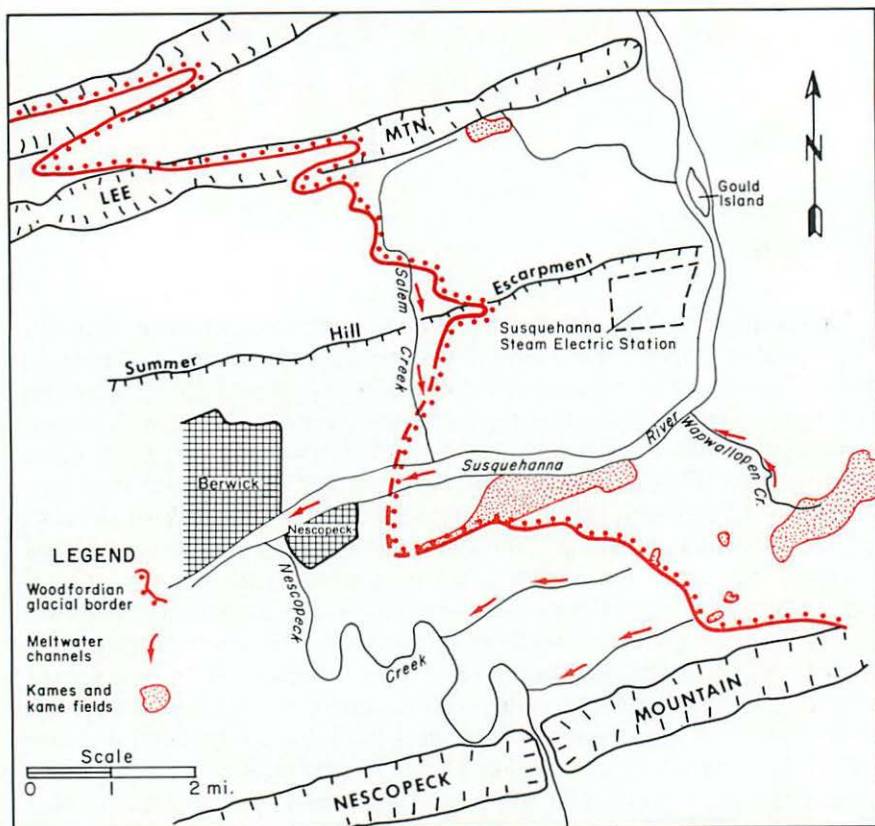


Figure 1. Woodfordian glacial border in the vicinity of Berwick, northeastern Pennsylvania (modified from Crowl and Sevon, 1980), showing location of major meltwater channels.

Nescopeck Creek on the south side of the river. The heads of the major meltwater streams are commonly marked by kames or kame fields along the margin (or a short distance behind the margin) of the Woodfordian moraine (Inners, 1978; Crowl and Sevon, 1980). The association of ice-contact features with preglacial stream valleys suggests that these old valleys became the loci of considerable meltwater flow very early in the history of deglaciation. Of the discharge channels named, only the Susquehanna River, far and away the largest of these features, is characterized by major deposition of outwash gravel. The channelways which to the writer's knowledge show the greatest amount of meltwater erosion are Wapwallopen Creek

and Salem Creek. Particularly good examples of scour features are evident along the latter stream.

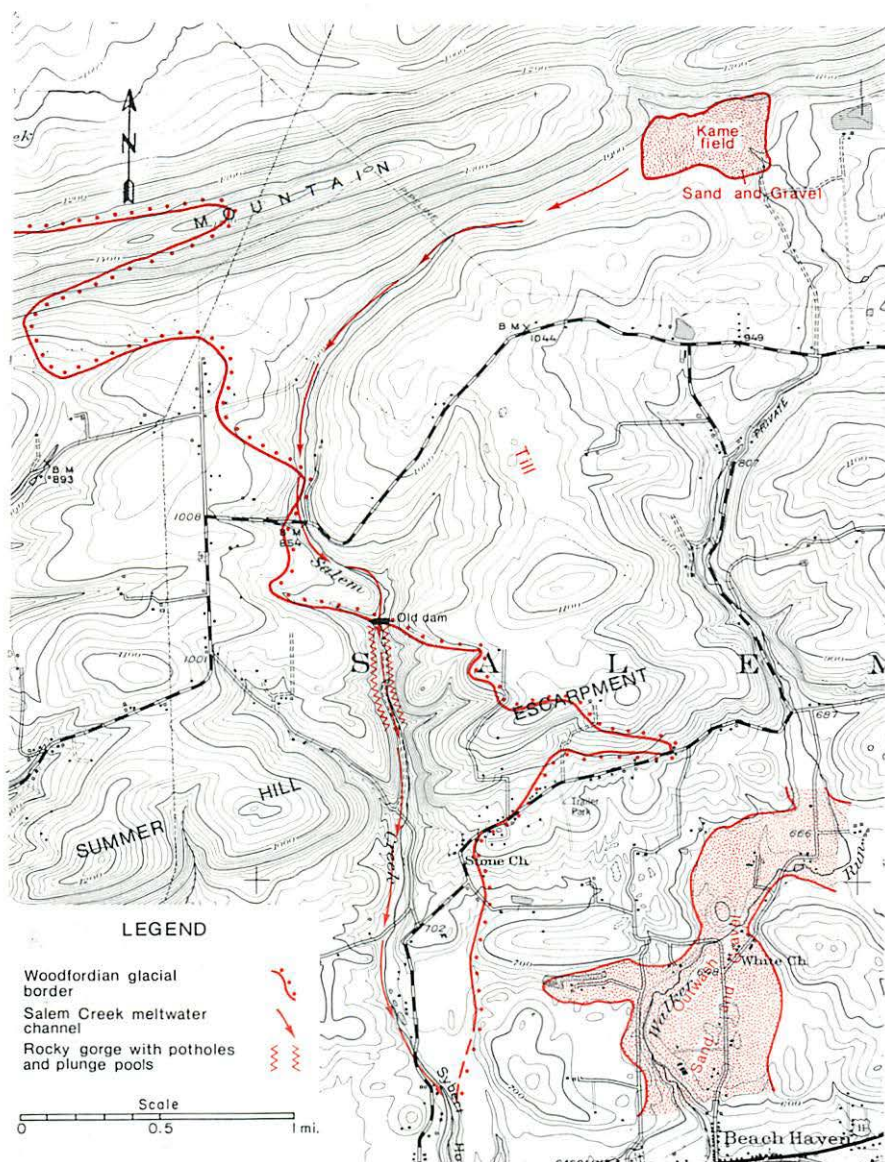


Figure 2. Generalized surficial geologic map of Salem Creek area (after Inners, 1978). Note deeply incised nature of valley north of Summer Hill escarpment.

Salem Creek is located about 2 miles northeast of Berwick in Salem Township, Luzerne County. The stream rises in a poorly drained, swampy area on the south side of Lee Mountain and forms a rather deep gorge through resistant rocks of the Catskill and Trimmers Rock Formations north of the Summer Hill escarpment at Stone Church (Figures 2 and 3). South of the escarpment relief along the stream is relatively subdued, except along its last 0.5 mile where it descends through Sybert Hollow to reach the level of the Susquehanna River. Total length of the creek is about 5 miles. Prior to the Woodfordian glaciation, Salem Creek probably headed in a deep notch on Lee Mountain about 0.4 mile north of its present source. Stream derangement in the vicinity of a 60 acre kame field has resulted in loss of this headwater area to a shorter stream that drains in a generally eastward direction to a junction with the Susquehanna opposite Gould Island, about 1.3 miles north of the Susquehanna Steam Electric Station.

The Woodfordian glacial border crosses Salem Creek about 2.3 miles above its mouth and trends northward parallel to the creek for

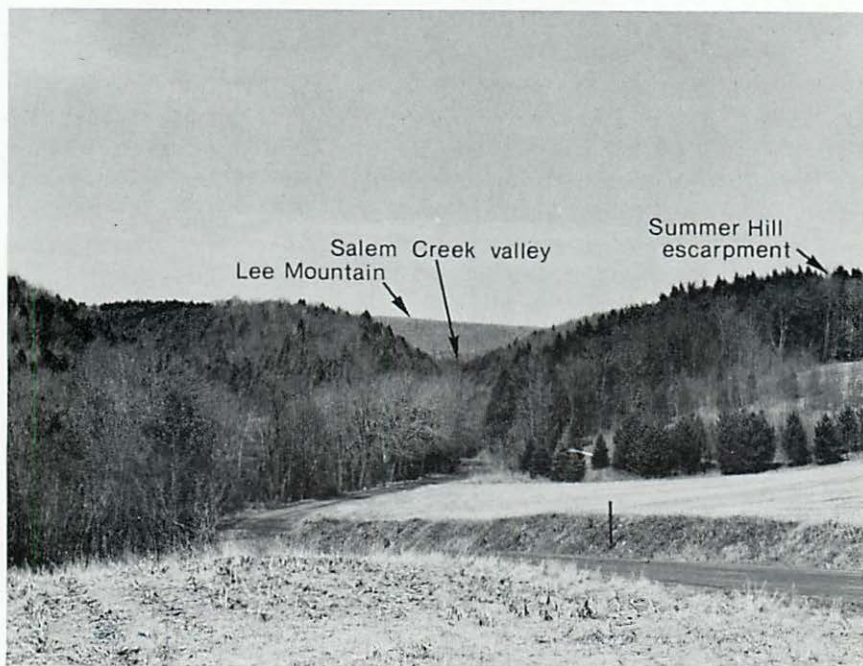


Figure 3. Salem Creek valley, looking north through gap in Summer Hill escarpment toward Lee Mountain.

about 1.4 miles to the base of Lee Mountain (Figure 2; Inners, 1978). Deposits associated with the Woodfordian border consist mainly of bouldery glacial till, surficial exposures of which are very abundant along L.R. 40028 (the road to Split Rock Farm) east of the creek. The large, pitted kame field just east of the head of Salem Creek is composed predominantly of stratified sand and gravel.

Although glacial meltwaters coursed down the entire length of Salem Creek during the early stages of Woodfordian glacial stagnation and retreat, the most spectacular evidence of meltwater erosion is found in a 1500 ft. reach immediately south of the glacial border at the old Berwick Water Company dam (Figure 2). Within this portion of the valley are several large potholes and/or plunge pools up to 15 ft. in diameter and 10 to 15 ft. deep that are scoured out of north-dipping Trimmers Rock siltstone and sandstone. Some of the potholes were formed by the coalescing of smaller erosional depressions. Although a few of these features may have been wholly circular pits that were later breached by stream downcutting, the larger ones may have been simply scoured into the bedrock walls of the channel by stationary eddies in the stream current. Probably the most impressive of these scour features is a conspicuous, smooth-walled "amphitheater" 6 ft. high, 9 ft. wide, and 4.5 ft. deep (into the hillside) situated on the east side of the valley about 1500 ft. downstream of the old dam (Figure 4). Other good examples of meltwater erosion include what appear to be large plunge pools on the west side of the valley at the old dam and at a small weir 1000 ft. downstream (Figure 5). Numerous large potholes also occur in a narrow, rocky gorge just below the weir.

The Salem Creek meltwater channel was activated when the Woodfordian continental glacier reached its terminal position about 15,000 years ago. At first meltwaters poured down the valley as active glacial ice continued to move forward to a stillstand position. Most of this water probably originated from melting at or near the front of the glacier. Once stagnation of the terminal zone of the ice set in, however, an active subglacial stream was initiated in the pre-existing stream valley, its head in an area of crevassed and rotten ice (now represented by the kame field) about 2 miles northeast of the glacial border. This area of collapsed ice served as a sump for numerous streams which flowed on and within the glacier. As the ice downwasted and backwasted over a period of tens or even hundreds of years, a steadily decreasing volume of meltwater cascaded down Salem Creek, subject to marked daily and seasonal variations.

Although the meltwater was undoubtedly heavily laden with sediment, the normally large volumes of water and the narrowness of the valley combined to flush most of the sediment out into the broad Susquehanna valley where it became part of the great North Branch valley train. As the sediment-charged waters poured over bedrock ledges and eroded laterally into the steep walls of the valley, deep plunge pools, potholes and furrows were carved into the resistant rocks north of the Summer Hill escarpment. With continued downcutting of the stream, some of these features were breached or partially obliterated. It is probable that active bedrock erosion along Salem Creek virtually ceased after final melting of ice in the



Figure 4. Polished, erosional "amphitheater" in Trimmers Rock siltstone on east side of Salem Creek, about 1500 ft. downstream of old dam. Staff is 5 ft. long.

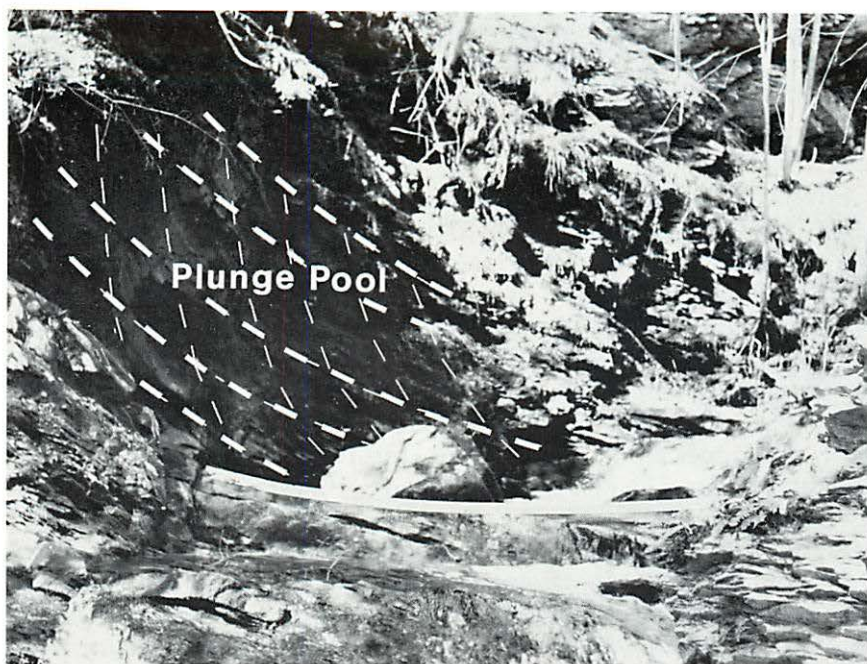


Figure 5. Large plunge pool or breached pothole located on west side of creek near concrete weir, about 1000 ft. downstream of dam. Feature—eroded into interbedded siltstone and shale of the Trimmers Rock Formation—is 10 to 12 ft. high on west (left) wall and 15 ft. in diameter. Large boulder lies in middle of smooth circular depression.

area and that the effects of recent erosion in the valley are relatively minor.

Even though Salem Creek in recent times does not approach its ancient magnitude, the stream is still capable of rising to destructive heights during periods of sustained runoff. One such flood episode occurred in the mid-1950's and resulted in the breaching of the 18 ft. high earth-rock dam of the Berwick (now Keystone) Water Company. Personnel of the Keystone Water Company (Berwick District) office report that the dam failed in mid-October, 1954, during rain storms spawned by Hurricane Hazel.

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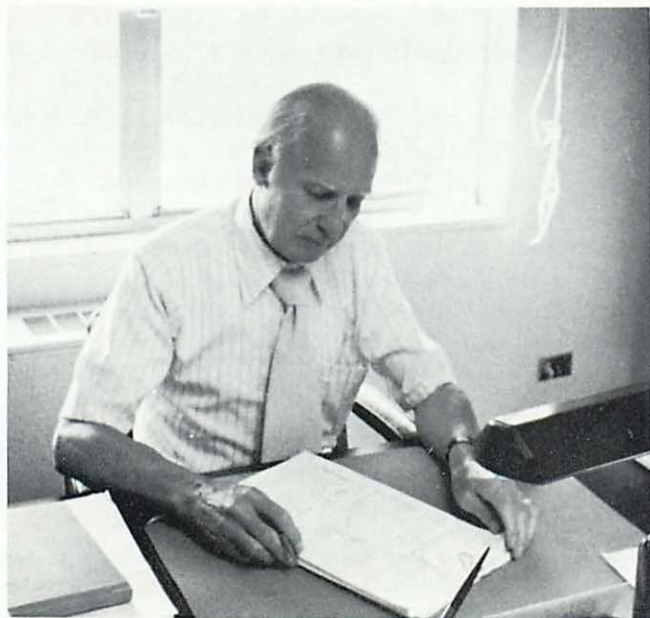
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Mineral Resource Division Chief Retires

Following a productive career with the Pennsylvania Geological Survey that spanned two decades, Bernard J. O'Neill, Jr. retired this past September, 1980. Most recently, Bernie served as Chief of the Mineral Resources Division, and over the years he completed a series of four extensive reports on Pennsylvania's clays and shales, two of the Commonwealth's most plentiful resources. Thanks to his efforts, the Bureau has chemical, mineralogic, and physical test results for 707 samples from across the State. Other major projects intended to assist the mineral industry include the popular "Directory of the Mineral Industry in Pennsylvania" and "Limestones and Dolomites of Pennsylvania."

Bernie first joined the Survey in 1962. Earlier, he had experience in a wide variety of minerals exploration and development projects for The New Jersey Zinc Company and the Foote Mineral Company. Among his accomplishments, he helped direct the difficult New Hartman shaft sinking at Friedensville. He graduated from the California Institute of Technology and Franklin and Marshall College after serving as an Army Air Corps pilot during World War II.

Bernie O'Neill and his wife, Betty, now plan to enjoy the relaxing climate of Florida. We at the Survey are proud to have had Bernie on our staff and wish the O'Neills well in all endeavors.



Ancient Eolianite (Wind-blown Sand)

In Centre County

Thomas M. Berg
Pa. Geological Survey

While doing reconnaissance mapping in Centre County for the new state geologic map, an unusual, very light gray sandstone was found within the Mauch Chunk Formation. The Mauch Chunk is Mississippian in age (about 330 million years old). In the central part of Pennsylvania, the formation normally comprises buff, clayey sandstone interbedded with red siltstone and shale. In the southwestern and south-central parts of the state, the Mauch Chunk Formation also includes the Loyalhanna Member, which is strongly crossbedded, calcareous sandstone or sandy limestone. The Loyalhanna has been traced as a mappable member from Altoona along the Allegheny Front to Sullivan County (Wells, 1974, p. 84). The Loyalhanna Member north of Altoona is a greenish-gray, crossbedded, calcareous sandstone. It forms a low cliff which is easily traced on aerial photographs, making it an important mapping unit. It is about 50 feet thick.

At an inactive quarry about 4½ miles east of Snow Shoe, Pennsylvania, the sandstone at the stratigraphic position of the Loyalhanna Member is very much different from the Loyalhanna exposed elsewhere along the Allegheny Front. It is not greenish-gray, but is very light gray to almost white. Nor is it calcareous. Close inspection of hand specimens reveals well-sorted and rounded quartz grains that have frosted surfaces. The quartz grains display better-developed sphericity than in sandstones above and below the Loyalhanna. The rock is very friable, and individual sand grains can be rubbed off hand specimens with moderate finger pressure. The sandstone is crossbedded, and breaks up into platy and slabby pieces (Figure 1).

Microscopic examination of a thin section of this sandstone reveals that it is a supermature quartzarenite (following classification scheme of Folk, 1968). It is composed of quartz grains (Figures 2 & 3) that have an apparent bimodal size distribution and are either medium grained or very fine grained to coarse silt size. The quartz framework is set in a binder that is a combination of sericite (2.0%) and kaolinite (1.2%) matrix, authigenic quartz overgrowth cement (3.6%), and a composite of sericite and microcrystalline quartz cement (5.0%). There are many voids in the thin section, and they make up 6.6% of the rock volume. (Although the thin section was impregnated with cementing medium, some plucking of grains may have occurred

because of the highly friable nature of the sandstone. This would somewhat increase the apparent void space.)

There are various interpretations for the origin of the calcareous sandstones of the Loyalhanna Member. They range from submarine sand waves to beaches and dunes (Wells, 1974, p. 84). The writer believes this noncalcareous, almost white facies of the Loyalhanna is attributable to a wind-blown dune environment, and that the sandstone can be tentatively described as an eolianite. The word "eolian" means "wind-blown." The crossbedding, low detrital clay



Figure 1. Outcrop of probable eolian sandstone in quarry at 41° 02'30"N/77°52'15"W in Snow Shoe SE 7½-minute quadrangle. Note large-scale cross-strata and slabby break-up of rock. Hammer gives scale.

content, good sorting (although bimodal), frosted and rounded quartz, lack of sedimentary and metamorphic rock fragments (which are less durable than quartz), and lack of heavy minerals all tend to point to an eolian environment of deposition. Allen (1970, p. 104) indicates that bimodal sorting can occur in interdune areas, even though most dune sands are unimodal. The finer mode in the bimodal sand was probably trapped in the "hoppers" between larger quartz grains.

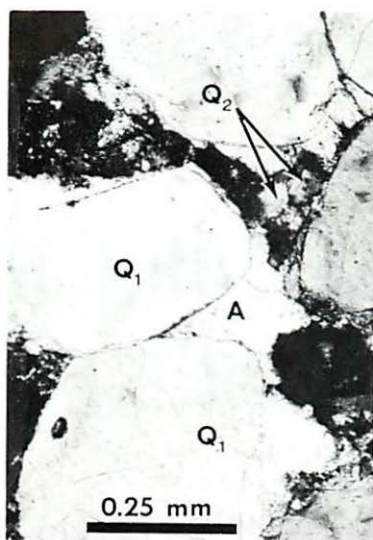


Figure 2. Photomicrograph of thin section of sandstone shown in Figure 1. Note rounded quartz grains of medium size (Q₁), quartz grains of coarse silt size (Q₂), and authigenic quartz overgrown (A). Crossed nicols.

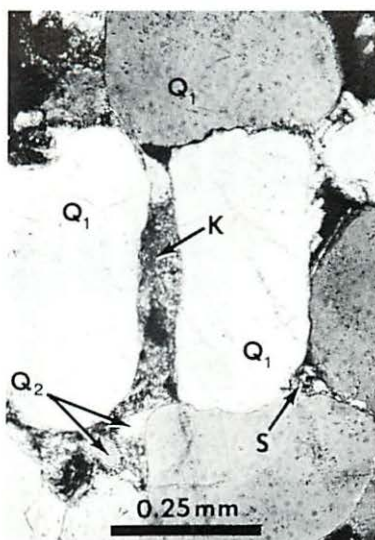


Figure 3. Photomicrograph of thin section of sandstone shown in Figure 1. Note rounded quartz grains of medium size (Q₁), quartz grains of coarse silt size (Q₂), pocket of kaolinite matrix (K), and small area containing composite sericite/microcrystalline quartz cement (S). Crossed nicols.

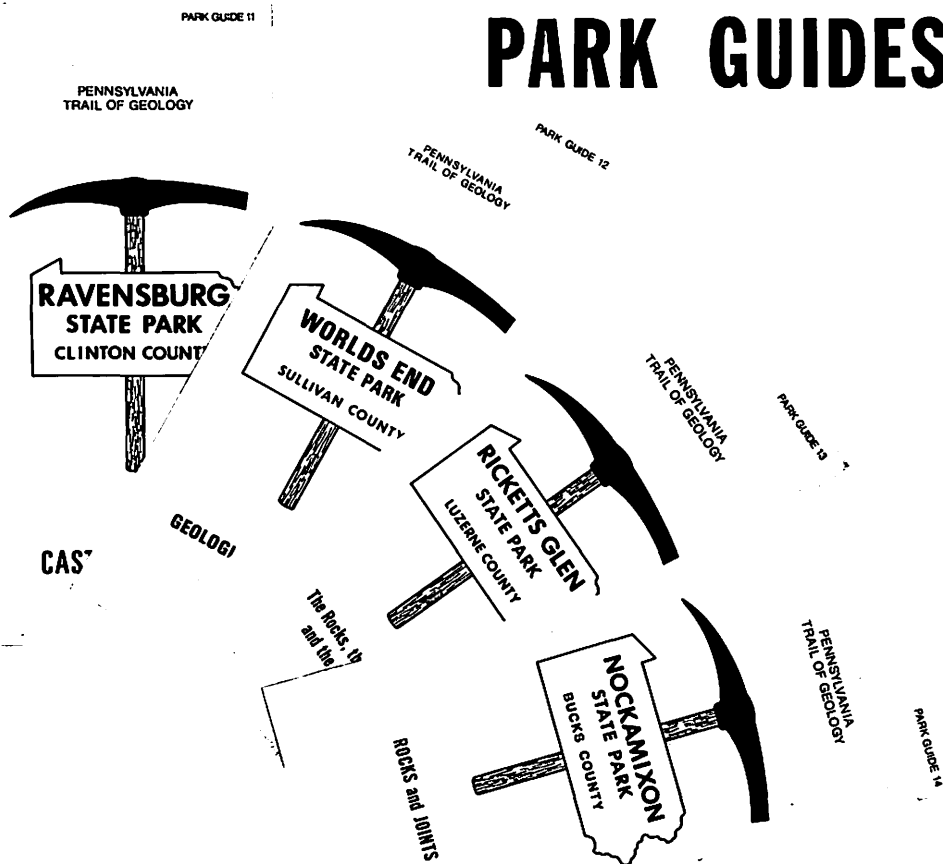
Further research on the Mauch Chunk depositional environments needs to be done, and this facies of the Loyalhanna Member, which may be an ancient eolianite, awaits detailed examination by students of sedimentology. Because this is one of the most quartz-rich and porous sandstones in the Mississippian and Pennsylvanian part of Pennsylvania's stratigraphic sequence, it may be of some economic significance either as a source of silica or as an aquifer. Our present knowledge of its lateral extent is very limited.

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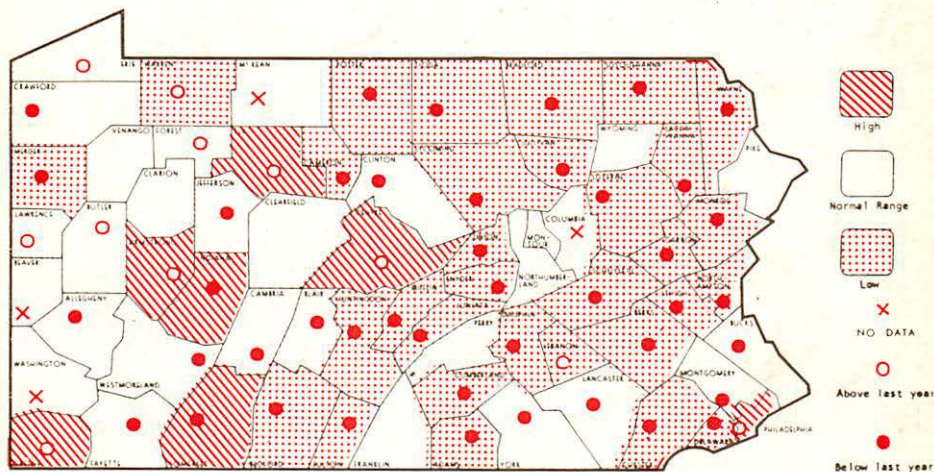
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GROUND-WATER LEVELS FOR NOVEMBER 1980



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