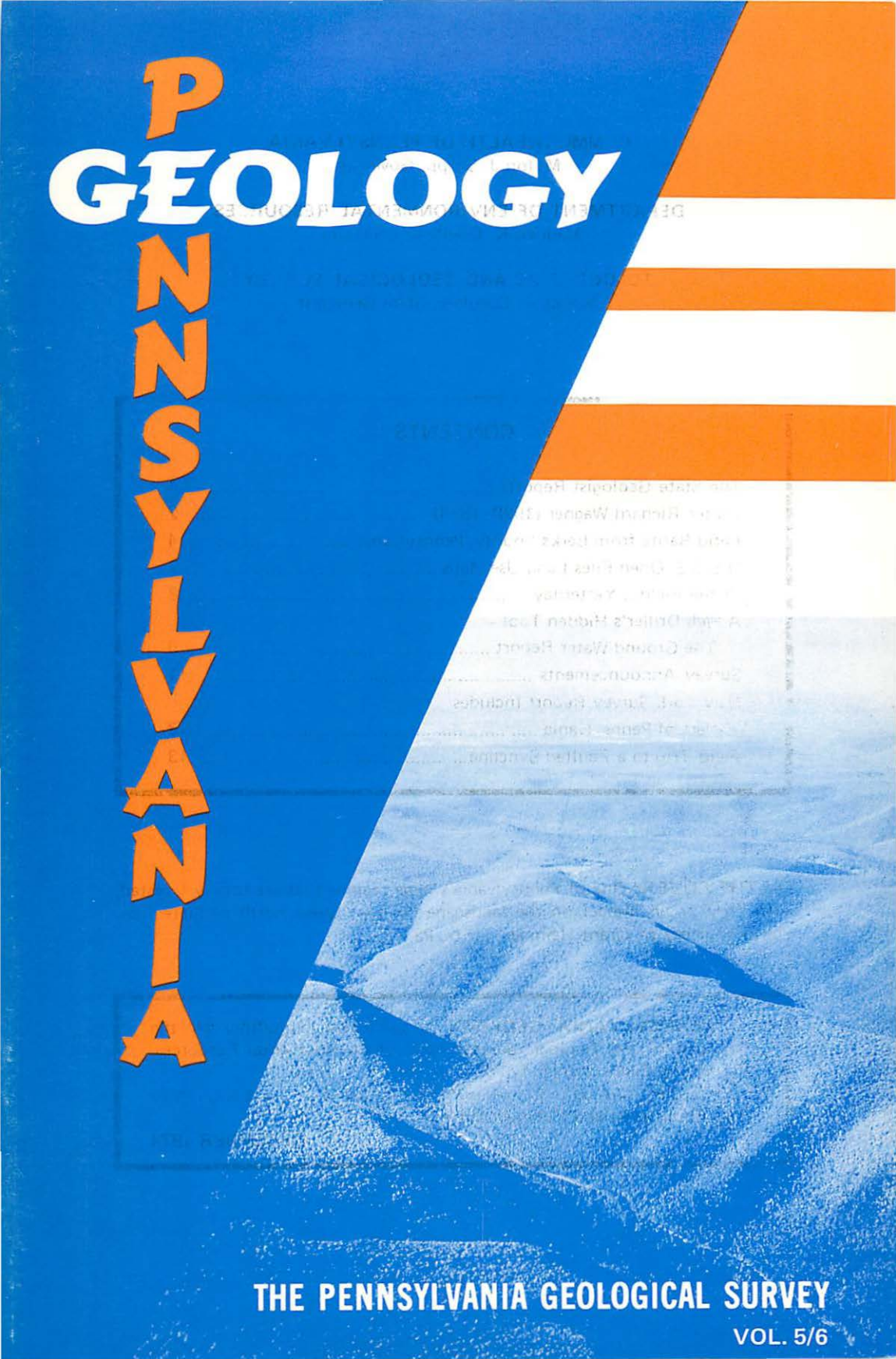
PENNSYLVANIA GEOLOGY



THE PENNSYLVANIA GEOLOGICAL SURVEY

VOL. 5/6

COMMONWEALTH OF PENNSYLVANIA
Milton J. Shapp, Governor

DEPARTMENT OF ENVIRONMENTAL RESOURCES
Maurice K. Goddard, Secretary

TOPOGRAPHIC AND GEOLOGICAL SURVEY
Arthur A. Socolow, State Geologist

CONTENTS

ON THE COVER: One of Pennsylvania's large regions that are totally forested, with little or no impact on the landscape by man. View north of Slate Run. Photo courtesy of Grant Heilman, Lititz, Pa.

PENNSYLVANIA GEOLOGY is published bimonthly by the Topographic and Geologic Survey, Dept. of Environmental Resources, Harrisburg, Pennsylvania, 17120.

DECEMBER 1974

FROM THE DESK
OF THE
STATE GEOLOGIST . . .

WE'RE PUTTING THE COUNTY ON THE MAP

The first of a new series of county topographic maps are now available for five of Pennsylvania's counties, with more on the way. Responding to the need for recognizing our counties as discrete, viable units from the standpoint of political, industrial, planning, agricultural, and recreational activities, the Bureau of Topographic and Geologic Survey initiated this program and arranged for its implementation as a cooperative project with the U. S. Geological Survey's Topographic Division. This is the first such state-federal county mapping program in the country and already several other states have enthusiastically started similar programs.

The county topographic maps now available are Sullivan, Jefferson, Montour, Forest, and Lehigh. Nineteen other counties are in progress and should be available within a year. The ultimate goal, if our budget permits, is to have these maps available for every one of our counties. This program is possible for programming only because we have already completed statewide coverage of even more detailed quadrangle topographic maps. These up-to-date quadrangle maps now permit the preparation of county topographic maps at very low cost.

The new county topographic maps show all landforms, water bodies, and slopes (by contours), as well as roads, trails, major buildings, and other man-made features. Political boundaries are clearly defined, including township boundaries. The 1:50,000 scale of these county maps was chosen to satisfy the needs of those who want to have maps somewhat like the old inch to the mile series of 15-minute quadrangle maps which were discontinued. The 1:50,000 scale also keeps us in step with the trend for future maps to utilize the metric system.

We believe that these new maps will be of extensive use to government officials, planners, industry, engineers, and the public. The scale of these maps and their orientation to county programs should make them usable by a wide range of citizens.

The county topographic maps for Sullivan, Montour, Jefferson, and Forest counties may be purchased at $2.00 each from the Distribution Section, U. S. Geological Survey, 1200 S. Eads Street, Arlington, Virginia, 22202. The Lehigh map is available for $1.00 each (plus tax) from the Pennsylvania Bureau of Publications, 10th and Market Streets, Harrisburg, Pa. 17125.

Arthur A. Socolow

WALTER RICHARD WAGNER

(1928 - 1974)

It is with deep regret that we announce the death of our colleague and friend, Dick Wagner, a long-time senior geologist at the Pittsburgh branch office of the Pennsylvania Survey. Dick died suddenly on October 21, 1974 at his home in Bethel Park, Pennsylvania.

Walter Richard Wagner was born in Baltimore, Maryland on October 27, 1928. When he was very young, the family moved to Philadelphia, Pennsylvania. Dick graduated from the Lansdowne High School in 1946 and entered the service of his country in October of that year in the United States Army. At the conclusion of his Army service in 1948, Dick entered the University of Pennsylvania, where he was awarded a B.A. degree in Zoology in 1952. Later that year he started work on his M.A. degree in Geology at Bryn Mawr College, Bryn Mawr, Pennsylvania, receiving the degree in 1955 after completing his thesis on a statistical study of Miocene Molluscs in zones of the Calvert Foundation, Maryland. During the summer of 1953 Dick worked for the U. S. Geological Survey in the Minerals Deposit Branch panning for heavy minerals on the New Jersey, Maryland, and Virginia coastal plain.

After graduating in 1955, his first job was as a geologist in the testing laboratories of E. L. Conwell and Company of Philadelphia, where he worked for a year. Hired at that time by the Pennsylvania Bureau of Topographic and Geologic Survey, Dick continued to work for the Survey until his untimely death.

During the early part of his career with the Oil and Gas Geology Division of the Survey, Dick specialized in the study of Cambrian and Ordovician stratigraphy of the subsurface of western Pennsylvania and later the Upper Devonian to Conemaugh rocks of Pennsylvanian age. He found time to teach a night course on earth sciences at Point Park College in Pittsburgh from 1967 to 1969 and to attend the University of Pittsburgh in 1968-69.

His first publication after joining the Survey in 1956 was the description of the drill cuttings of a deep well in Snyder County, Pennsylvania. Descriptions of other wells followed and in 1959 his "Catalogue of Deep Well Samples and Geophysical Logs" was published by the Survey. One of his most outstanding contributions, "The Stratigraphy of the Cambrian to Middle Ordovician Rocks of Central and Western Pennsylvania" was published by the Survey in 1966. Dick was the single or senior author of ten Survey publications and junior author of fifteen. Seven reports were published in national journals; other reports of his are on open file and four are being prepared for publication.

Geology was Dick's avocation as well as his vocation. Except for being with his family, he enjoyed nothing better than to meet with his fellow geologists and talk shop. He was independent-minded and thorough, painstaking, meticulous, and very productive in his work. Dick was a philosopher with a quiet wit. His keen analytical mind produced conclusions that were based on a deliberate and thorough analysis of all the phases of a particular problem.

Dick was a member of the Geological Society of America, the American Association of Petroleum Geologists (a member of several committees), Pittsburgh Geological Society (President 1966-67), Northern Appalachian Geological Society, American Association for the Advancement of Science, and the Society of Sigma Xi. He gave numerous talks and was the leader of many field trips. His biography is included in Who's Who in the East, 13th Ed.

Dick is survived by his widow, Agnes; their five children, Susan, Richard, Karen, John, and Barbara. His friends and colleagues also feel a sense of deep personal loss by his departure. The Appalachian area geological fraternity has lost a highly valued member at the height of his career.

FETID BARITE FROM BERKS COUNTY, PENNSYLVANIA

Several tons of fetid barite nodules have been found scattered in the fields of the Roy McLain farm (formerly R. and M. Frantz farm) located 1.4 miles southeast of Frystown, Tulpehocken Township, Berks County. The main area of barite is about 1,000 feet west of the R. McLain house and there is a lesser concentration about 500 feet north of the house. This occurrence was shown to the author by Mr. Milt Leet of Blue Ball and Mr. Jan Wise of Myerstown.

The barite on the McLain farm occurs principally as nodules which consist either of millimeter-sized, tabular barite crystals (Photo 1) or coarse, crystal cleavages up to 5 inches long radiating from a common center (Photo 2). In a few cases, the tabular aggregate variety forms a core for the radiating variety. The radiating crystals often have a white to gray central zone down their length and a black rim. The irregular crystal cleavage surfaces through the nodules suggest deformation after formation, whereas the nodular habit suggests growth before lithification. Shale chips included in some of the nodules indicate that the nodules formed within the shaly rocks upon which they now lie. Of lesser importance by volume are white barite-calcite veins which cut limestone and probably represent post-lithification redistribution of barite, probably during the Taconic or Appalachian orogenies.

Photo 1

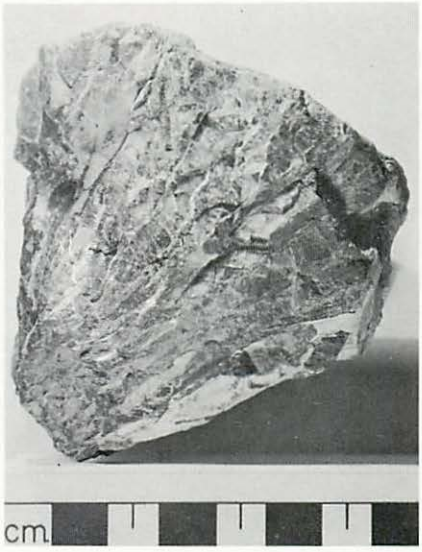


Photo 2

Unlike most barite, the McLain farm nodules give off a very strong odor when broken or rubbed against one another. To the author, the odor resembles carbide-generated, impure acetylene, but other staff members describe it as "sour hydrocarbon," "rotten egg" (implying hydrogen sulfide), or just plain "obnoxious" (implying mercaptans).

This is not the first report of fetid barite in Pennsylvania, as Genth (1875, p. 146) noted: "A fetid barite in brownish, radiating and columnar, ferruginous masses occurs at Heidelberg, Berks County;" and D'Invilliers (1883, p. 395) adds "also at Mt. Aetna, in Tulpehocken township." Mr. Jan Wise's father is said to have collected this type of barite a few miles east of the R. McLain farm.

Elsewhere in the Appalachians, Lawrence (1938) described dark, fetid, crystalline barite from the Fall Branch District, northeastern Tennessee. He reported that the area was underlain by thrust-faulted upper Knox Group dolomite (roughly equivalent to the lower Ordovician Beekmantown Group of Pennsylvania) and lower middle Ordovician Athens Formation shale. Lawrence (1938, p. 195) reported that ". . . stock piles exposed to summer sunshine had to be covered with canvas to protect the barite. If not so protected, it will disintegrate almost to a powder in a short time, and the decrepitation is so rapid that a crackling sound, like a light summer shower falling on dry leaves may be heard at a distance of several yards. The fetid odor is also given off during this decrepitation and is strongly noticeable at some distance."

Carpenter and Fagan (1969) also have described barite nodules from northeastern Tennessee and southwest Virginia which are very similar to the same two types of nodules from the R. McLain farm in Pennsylvania. Carpenter and Fagan found seven barite nodule occurrences in the basal 50 feet of the Athens Formation shale over a distance of 75 miles. Edmundson (1938) also has described the same type of black, fetid barite in Athens Formation shale from the Caldwell prospect, 15 miles north of Roanoke, Virginia. In agreement with Revelle and Emery (1951) who studied similar barite concretions off the coast of California, Carpenter and Fagan believed that this type of barite precipitates where highly saline, barium chloride-bearing hydrothermal solutions ascend into stagnant, sulfate-bearing marine sediments. Carpenter and Fagan relate barite mineralization in their area to associated zinc and lead mineralization and conclude that: 1) barium, zinc and lead mineralization may have occurred after Knox (Beekmantown equivalent) unconformity and that 2) barite nodules in shale may define an exploration target for zinc and lead in the underlying Knox Group carbonate rocks favorable for these latter metals.

The host rock on the McLain farm has been customarily referred to the middle Ordovician Martinsburg Formation, but associated rocks of this area have some characteristics not found in definite Martinsburg Formation appearing in normal stratigraphic sequence elsewhere. Some of the varietal lithologies have been established to be at least in part stratigraphically older than the Martinsburg Formation (Epstein, Epstein, and Bergstrom, 1972), and at least as old as some of the carbonate rocks inferred to underlie the shaly rocks of this area. Distinct thin limestone interbedded in the apparent barite host is believed to identify the host with the allocthonous (transported) rocks.

Because of the frequent association of barite with zinc and lead mineralization, the author collected a stream sediment sample to test for possible anomalous metals on the R. McLain farm. Considering the lithology of this area, the trace metal values are not anomalous (Rose and Keith, 1971) and do not suggest zinc or lead concentrations in the immediate vicinity. Exotic blocks of limestone now exposed within the Martinsburg are possible hosts for zinc or lead. The area from Berks County east to the Delaware River is favorable because of the facies change from limestone on the west to dolomite on the east within the Beekmantown Group beneath the middle Ordovician unconformity present in eastern Pennsylvania (Hobson, 1963). Some of this area already has been geochemically surveyed by Rose (1971), who found zinc anomalies in Martinsburg terrain NW of Allentown, Lehigh County.

There are other potentially important aspects of this barite. The observation of Carpenter and Fagan (1969) that the nodules are greatly restricted stratigraphically and present in a host rock slightly older than the Martinsburg Formation suggests that these easily mapped barite nodules might be possible stratigraphic markers in Berks and adjacent Lebanon Counties.

Barite itself has value. Barite is increasingly in demand for heavy drilling muds necessary for deep oil exploration.

Robert C. Smith, II

REFERENCES

Carpenter, R. H. and Fagan, J. M. (1969), *Barite nodules in the Athens Shale in northeastern Tennessee and southwest Virginia,* Southeastern Geology, v. 10, p. 17-29.

D'Invilliers, E. V. (1883), *Berks County,* 2nd Pa. Geol. Survey rept. DDD.

Edmundson, R. S. (1938), *Barite deposits of Virginia,* Va. Geological Survey Bull. 53, University of Va.

Epstein, J. B., Epstein, A. G., and Bergstrom, Stig M. (1972), *Significance of lower Ordovician exotic blocks in the Hamburg Klippe, eastern Pennsylvania,* U. S. G. S. Prof. Paper 800-D, p. 29-36.

Genth, F. A. (1875), *Mineralogy of Pennsylvania,* 2nd Pa. Geol. Survey, rept. B.

Hobson, J. P. (1963), *Stratigraphy of the Beekmantown Group in southeastern Pennsylvania,* 4th Pa. Geol. Survey rept. G37.

Lawrence, R. A. (1938), *Black barite in upper east Tennessee,* Tenn. Acad. Sci. Jour., v. 13, p. 192-197.

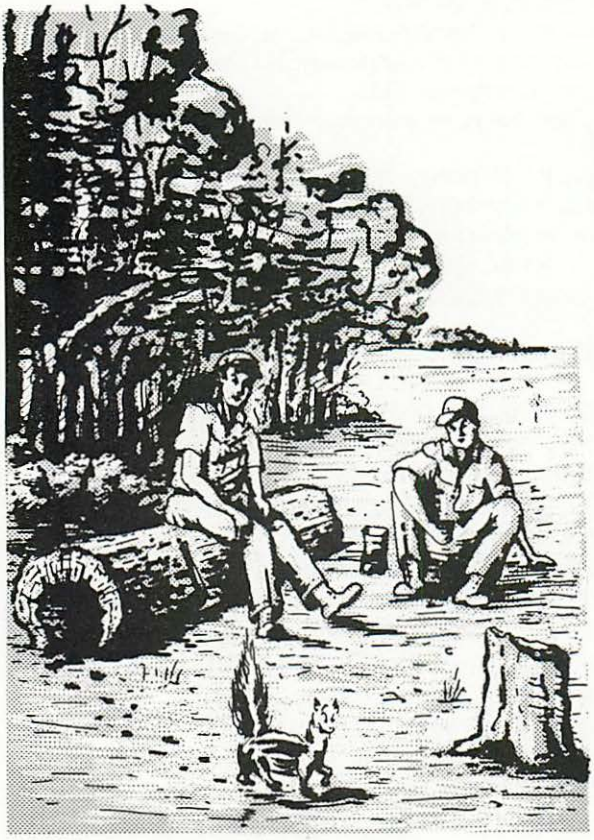
Revelle, Roger and Emery, K. O. (1951), *Barite concretions from the ocean floor,* Geol. Soc. Am. Bull. 62, p. 707-724.

Rose, A. W. (1971), *Trace metals in stream sediment of southeastern Pennsylvania,* Part 3 with M. L. Keith. Bull. 86, Earth and Mineral Sciences Expt. Sta., Pa. State Univ., University Park, Pa.

U.S.G.S. open files land use maps

The U. S. Geological Survey has open filed land use maps and associated maps of southeast Pennsylvania. Land use maps at a scale of 1:250,000 (one inch equals approximately four miles) overlaid upon the standard 1:250,000 quadrangle maps (Newark, Wilmington, and Baltimore sheets) of southeast Pennsylvania have been released for Bucks, Montgomery, Chester and Delaware counties and the City of Philadelphia. In addition, 1:100,000 land use maps have been released for the same area. The 1:250,000 maps have been prepared from the Earth Resources Technology Satellite (ERTS-1) and show level one categories of urban, built-up, agriculture, forest land, water, nonforested wetland, and bare land areas. The 1:100,000 maps are high-level aerial photo mosaics, land use as of 1970, land use changes between 1970 and 1972, drainage basin maps, census tract and county boundary maps and cultural feature maps. The area of Pennsylvania is included in the Pottstown, Quakertown, Newtown, Burlington, Philadelphia and Coatesville 1:100,000 maps. All of these maps have been prepared by the Central Atlantic Region Ecological Test Site project (CARETS). This project is a jointly sponsored U.S.G.S.-NASA demonstration project to test the applicability of data from ERTS-1 and high-level photography. Copies of these maps are on file for viewing only at the U.S.G.S. Library, Room A-100, National Center, Reston, Virginia. Reproducible copies are on file at the U.S.G.S. Public Inquiries Office, GSA Building, 19th and F Streets, N.W., Washington, D.C. 20242. Reproductions can be obtained for the cost of reproduction through local reproduction companies. If additional information is required about these maps, contact the Office of the Chief Geographer, U.S.G.S. National Center, 115, Reston, Virginia 22092.

in the field ..... YESTERDAY



Believe it or not there are common-interest and sometimes just plain humorous incidents that happen in the course of doing geologic field work. These stories are never told in modern, scientific publications produced as a result of field work. However, at the time it happened each geologist is vitally involved.

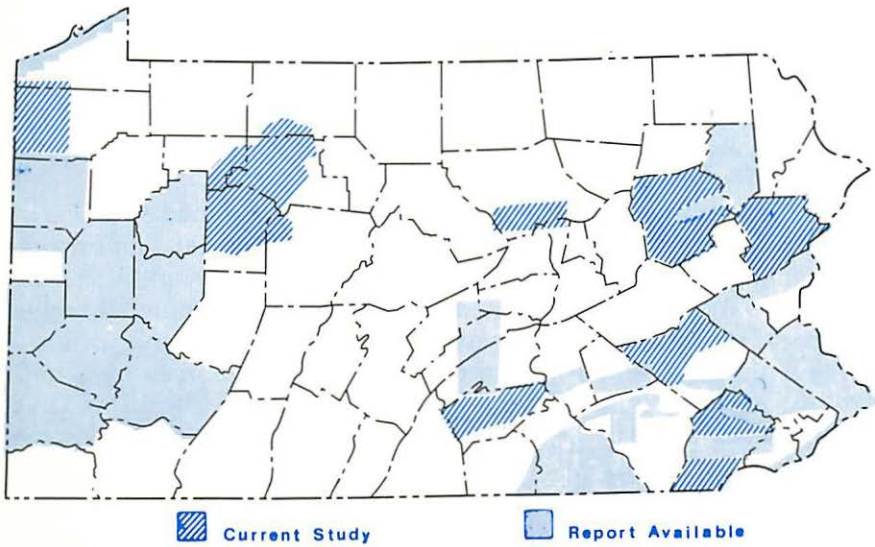
I recall one hot summer day working in the field with Carlyle Gray near Cornwall on the Lebanon quadrangle report (later to become the Survey's Atlas 167c). It was the summer of 1952 when we were alternating between mapping limestones near Cornwall with mapping the underground ore deposit at the Cornwall Iron Mine. This particular day we were mapping limestones near North Cornwall. As was the custom then, we carried our lunch and at noon picked a pleasant shady spot to eat it. That day a spot was chosen in a small grove of trees in open farmland just east of North Cornwall. We sat down and started eating and talking both geology and local affairs. As I recall Carlyle was sitting on a large fallen tree log and I on the ground. Sandwiches, a fresh tomato or two picked up along the way, and ice tea made up the lunch. A jug of ice tea, compliments of my mother, always seemed to accompany us each day that year. Shortly after we started eating, a full-grown adult skunk came out from the log Carlyle

was sitting on and nonchalantly walked past us and into a small burrow at the base of a stump. I don't know if he saw us or not but either way he didn't care and we, in turn, were very lucky. After recovering from momentary shock, I think we had a good laugh and continued mapping limestones.

Alan R. Geyer

A WELL DRILLER'S HIDDEN TOOL – THE GROUND-WATER REPORT

For many years the Pennsylvania Geological Survey has published reports on ground water in Pennsylvania prepared by the U. S. Geological Survey as part of a cooperative federal-state program. These reports have been used by geological and engineering consultants and planners for just as many years in decision-making processes involving water supplies. Some well drillers have also seen the value of these reports in improving their ability to select and/or evaluate well sites and, thus, enhance their competitive position while reducing costs, expanding business, and providing better customer service.



Areas of Pennsylvania covered by ground-water reports

For you drillers who are not aware of these reports or how they can be used for business purposes, the following thoughts may stimulate your interest in acquiring them.

Tables of data on wells and well water chemistry contain a wealth of information on well casing, and bedrock depths, water levels, rock types, yields, and water quality. Accompanying maps show the locations of these wells and the distribution of different rock units. From this basic information, you can get a good idea of what to expect of a well drilled at any site in the report area and adjacent areas that are underlain by the same rock units.

When you have predicted physical characteristics of a well, approximate costs can be determined and a reasonable price estimate or range can then be given to the customer along with a general description of the finished well, including pump size and depth setting.

From the text, other tables, and illustrations, you may obtain interpretive information that can provide a better site evaluation, awareness of potential drilling hazards, or the key to solving a customer's problem of water quantity or quality. Knowledge of potential hazards will enable you to anticipate problems which might otherwise drive costs above quoted prices. If potential problems exist, these can be discussed with the customer prior to drilling. Keeping the customer on your side in the face of adverse drilling situations is important to customer satisfaction. Detailed study of the reports frequently will enable you to understand how the ground-water system works in your area as well as how it fits into the complete hydrologic system and ultimately the environment of the area. The knowledge you have gained through experience when combined with that derived from reports can form the basis for excellent presentations to professional organizations, civic groups, and individuals in the area of your drilling activities.

A series of six regional reports are available for broad coverage of the entire state of Pennsylvania, as well as 10 individual county reports. Smaller areas are covered more intensively by additional reports. The index map shows areas of local studies completed and in progress. Information on areas of current studies is available, prior to publication of a report, from the U. S. Geological Survey personnel actively engaged in the study. A complete listing of all available ground water reports can be obtained by writing the Pennsylvania Geological Survey.

SURVEY ANNOUNCEMENTS

CORNWALL STUDY PUBLISHED

The world reknowned iron ore deposit at Cornwall, Pennsylvania, which began operation prior to the Revolutionary War, is described in great detail in the Pennsylvania Geological Survey's new report, "Geology and Origin of the Triassic Magnetite Deposit and Diabase at Cornwall, Pennsylvania," by Davis Lapham and Carlyle Gray.

The report is the culmination of years of intensive geologic mapping in the mines and detailed laboratory research. This result is one of the most comprehensive geologic reports ever issued on a Pennsylvania mineral occurence. Discussions include the stratigraphy and structure of Cornwall as they relate to the entire Triassic geologic basin, descriptions of the Cornwall ore bodies and their origin in relation to other Triassic area magnetite occurrences, and descriptions of the diabase and associated metamorphism. Many new concepts are put forth regarding origin of the ore deposit, structural deformation, geochemical alteration, and diabase petrology.

The importance of this report is not only as a scientific analysis of a unique ore deposit which has contributed heavily to Pennsylvania's history and economy, but also as a guide to exploration for additional iron ore deposits of the same type. The report will be of interest to the mining community, professional geologists, educators, planners, and historians.

Bulletin M 56, "Geology and origin of the Triassic Magnetite Deposit and Diabase at Cornwall, Pennsylvania," contains 343 pages, 23 plates, 58 figures, 38 tables, and three full-color maps. It is available for $9.35 (plus sales tax for Pa. residents) from the Pa. Bureau of Publications, P.O. Box 1365, Harrisburg, Pa. 17125.

1973 OIL AND GAS DEVELOPMENTS RELEASED

The oil crisis and the related price increase has resulted in a marked increase in oil and gas exploration and drilling activity in Pennsylvania in 1973. A full report on those activities is contained in the new publication issued by the Pennsylvania Geological Survey, "Oil and Gas Developments in 1973," by William S. Lytle.

In 1973 the total of all wells drilled in Pennsylvania was 1099, up by 134 over the prior year. Of these wells, 99 were new exploratory and 1,000 were development. Venango and McKean Counties were the most active oil areas, with 205 and 126 new wells respectively. Indiana County was the most active gas area with 312 new wells.

The increased activity resulted in increases in oil reserves, gas production, and gas reserves. Oil production for the year was 3,282,000 barrels and gas production was at 78,514 million cubic feet.

These outstanding developments are detailed in Bulletin PR 187, containing 44 pages replete with maps, tables, and illustrations. This publication is available for $1.40 (plus sales tax for Pa. residents) from the Pa. Bureau of Publications, P.O. Box 1365, Harrisburg, Pa. 17125.

SUBSURFACE SECTIONS ON OPEN FILE

Sepias of nine mechanical log cross sections of the subsurface rocks of Western Pa., Tully (M. Devonian) to Queenston (U. Ordovician), by Louis Heyman, and a location map of these sections will be placed on open file by the Pennsylvania Geological Survey with this announcement. The datum is the top of the Onondaga limestone and the vertical scale is 1 inch equals 100 feet. Only major correlation lines are shown on these sections. The final edition will include more detailed correlations, indications of lithology including location of salt beds, oil, gas and water shows, and an explanatory text; the final edition is expected to be available in 1975.

Blue line prints of these open file sections are available at cost of copying by applying to the Oil and Gas Geology Division, Pennsylvania Geological Survey, Department of Environmental Resources, 1201 Kossman Bldg., 100 Forbes Avenue, Pittsburgh 15222.

NEW OPEN FILE REPORT ON THE AGE OF PRECAMBRIAN ROCKS IN ERIE COUNTY

The Pennsylvania Geological Survey is placing on open file a 40-page report on *Interpretation of K-Ar and Rb-Sr Isotopic Dates from a Precambrian Basement Core, Erie County, Pennsylvania.*

A well drilled near Lake Erie in Pennsylvania penetrated Precambrian rocks at a depth of 5,952 feet. Rock samples from the well

were studied in an effort to describe the complex events which have affected basement rocks in this area. Included are petrographic descriptions, radiometric age dates, geologic description of the processes of rock evolution and the regional geologic setting. A 908 million year K/Ar age on the gneiss contrasts strongly with Rb/Sr ages of about 550 million years on gneiss and granite. The report is augmented by four illustrations and five tables of mineral compositions and age dates. It is available for examination in the Survey office, 419 Towne House Apartments, 660 Boas Street, Harrisburg.

NEW YORK SURVEY REPORT INCLUDES PART OF PENNSYLVANIA

Our sister Geologic Survey of New York has issued two new reports that include part of Pennsylvania. Map and Chart Series #14 by Nancy A. Wright, "Subsurface Tully Limestone in New York and Northern Pennsylvania," contains an isopach map, structure contour map and correlation sections indicating that the "Tully" limestone of Western Pennsylvania in reality is the Tichenor limestone.

Map and Chart Series #18 by L. V. Rickard is entitled "Stratigraphy and Structure of the Subsurface Cambrian and Ordovician Carbonates of New York." The report consists of 19 plates and text and gives information on correlation of stratigraphic units and wells as well as isopach and paleogeologic maps of the various major units. The "Northern Tier" counties of Pennsylvania are covered by this report.

Map and Chart Series #14 is $1.50, #18 is $5.00. Check or money order should be made payable to N.Y. State Education Department and mailed to Gifts and Exchange Section, N.Y. State Library, Albany, N.Y. 12224.

FIELD TRIP to a faulted syncline

Many excellent exposures may be seen along Interstate 81 in Pennsylvania. The most outstanding of these occurs at exit 39 about 5 miles southwest of Hazleton. Here Spring Mountain, a ridge trending ENE, has been cut through to provide passage for the highway (Figures 1 and 2).

Three major geological features may be observed at this outcropping. Overall, the road cut exposes a complete syncline with rock

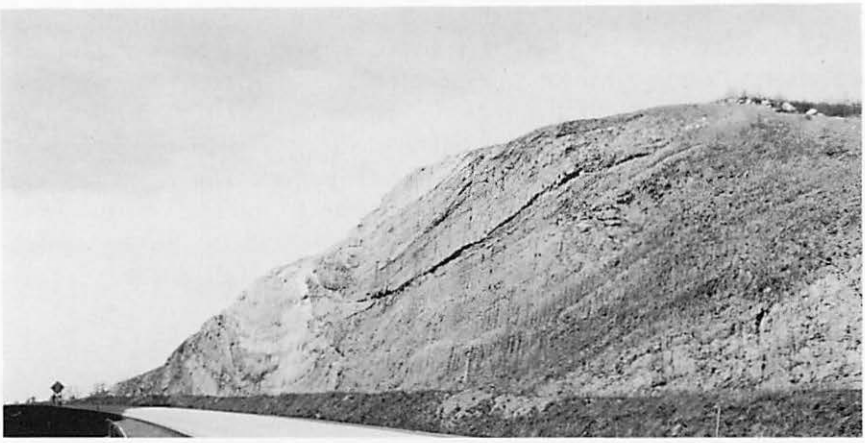


Figure 1. View of faulted syncline from the south.

layers dipping gently south at the north end and gently north at the south end.

Secondly, this syncline has been disrupted by one major and several minor faults with the primary effect being that the south side of the syncline has been lifted, relative to the north side, by at least 50 feet and probably more.

Thirdly, the syncline exposes the contact of the Pottsville and and Mauch Chunk Formations marked by the change from reddish, brownish and gray shaly rock (Mauch Chunk) to lighter gray and brown sandstone and conglomerates (Pottsville). Both of the rock units are Mississippian in age and were deposited approximately 300 million years ago.

Several photographs were taken of this exposure during April 1974 and composited to show the details of the cut. A sketch was made of the important geologic features which are numbered on the sketch and discussed below.

(1) The prominent change from reddish shaly rocks to lighter grayish sandstones and conglomerates is the contact between the Mauch Chunk and Pottsville Formations.

(2) The prominent south dipping discontinuity is a reverse fault which has moved the south portion of the syncline upward and northeast over the northern part of the syncline. The relative sense of movement of the south block over the north block classifies this as a reverse fault.

(3) This south dipping discontinuity is a reverse fault also but apparently has moved the layers only a few feet.

(4) and (5) These two discontinuities appear to be faults that nearly parallel the layers of rock. Their apparent movement has been to move the upper rocks southward over the lower rocks or vice versa. It is impossible to determine how much movement occurred at these breaks. In addition, these discontinuities may be related to original discontinuities in deposition of the rocks. Many of the discontinuations and intersections of the layers of sandstones are apparently the result of "cross bedding," a type of layering at angles to other layering that is formed when coarse materials are deposited by rapidly moving water.

(6) The large rounded blocks of sandstone which are discontinuous and are surrounded by less coarse material may be pieces of sandstone that slumped from originally continuous layers and became surrounded by finer material.

(7) The vertical or near vertical fracturing that crosses the south dipping layers is a set of fractures called cleavage.

If you plan to visit this locality, extreme caution should be exercised. Traffic on the interstate is heavy and fast; the road curves at both ends of the cut so that oncoming vehicles cannot see all parts of the highway; the walls of the cut are very steep and subject to rock falls.

This is a unique geologic exposure which graphically illustrates a wide array of geologic features and processes. It is well worth a trip to see and study this outstanding feature.

This feature and other exposures along I 81 are also described in a free pamphlet, "Geologic Field Trip, I-81 from Harrisburg to Hazleton," available from the Pennsylvania Geological Survey.

Donald M. Hoskins

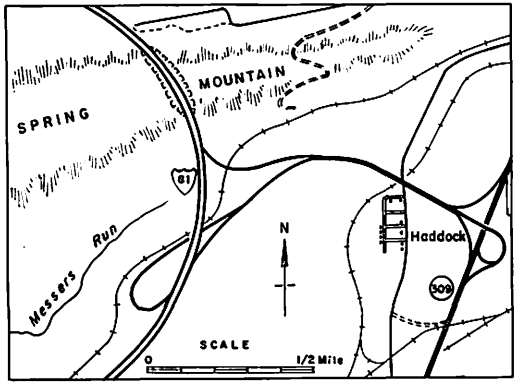


Figure 2. Location map.

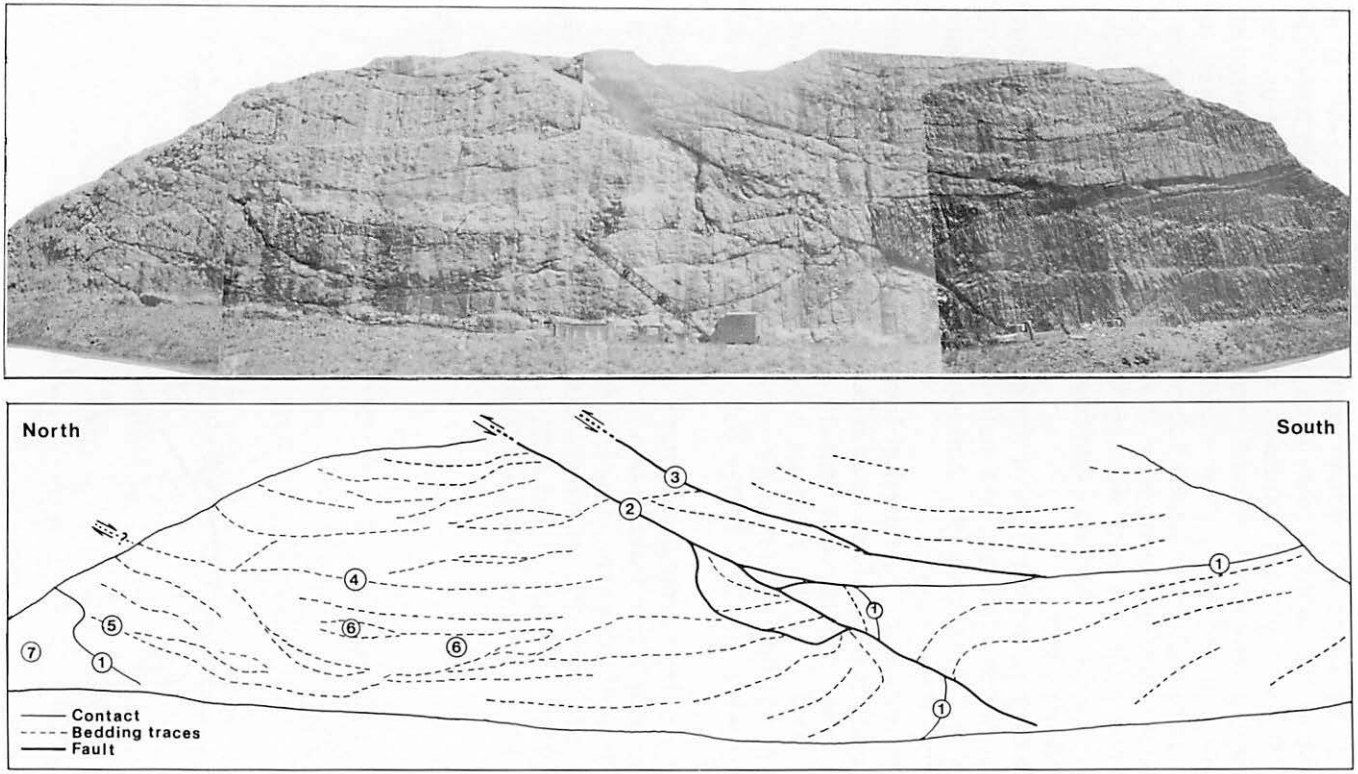


Figure 3. Composite photograph and explanatory sketch of roadcut.

PENNSYLVANIA GEOLOGICAL SURVEY STAFF

Arthur A. Socolow, *State Geologist*
Donald M. Hoskins, *Assistant State Geologist*

TECHNICAL SERVICES

Shirley J. Barner, *Stenographer*
Sandra Blust, *Librarian*
Joanne Bowman, *Typist*
John G. Kuchinski, *Draftsman*
Christine Miles, *Asst. Geological Editor*
Virginia Milewski, *Draftsman*
Mary A. Miller, *Stenographer*
Marjorie Steel, *Stenographer*
Albert Van Olden, *Draftsman*
John P. Wilshusen, *Geological Editor*

ENVIRONMENTAL GEOLOGY DIVISION

Alan R. Geyer, *Division Chief*

Jesse Craft, *Geologist* (Pittsburgh Office)
Eugene H. Hess, *Geologist*
Evan T. Shuster, *Geologist*
Donna M. Snyder, *Stenographer*
Grace Tyson, *Clerk*

GEOLOGIC MAPPING DIVISION

Samuel I. Root, *Division Chief*

Thomas M. Berg, *Geologist*
William E. Edmunds, *Geologist*
Rodger T. Faill, *Geologist*
Albert D. Glover, *Geologist*
Jon D. Inners, *Geologist*
David B. MacLachlan, *Geologist*
Phyllis Ritter, *Typist*
William D. Sevon, *Geologist*
Mark A. Sholes, *Geologist*
Viktoras W. Skema, *Geologist*
John H. Way, Jr., *Geologist*
Richard B. Wells, *Geologist*

MINERAL RESOURCES DIVISION

Davis M. Lapham, *Division Chief*

John H. Barnes, *Geologist*
John C. Benson, *Typist*
Leslie T. Chubb, *Laboratory Technician*
Bernard J. O'Neill, *Geologist*
Robert C. Smith, *Geologist*

OIL AND GAS DIVISION

1201 Kossman Bldg.
Stanwix Street, Pittsburgh, Pa. 15222

William S. Lytle, *Division Chief*

Lajos Balogh, *Draftsman*
Robert Fenton, *Laboratory Technician*
Lillian Heeren, *Draftsman*
Louis Heyman, *Geologist*
Cheryl Cozart, *Stenographer*
Elizabeth A. Eberst, *Typist*

TOPOGRAPHIC DIVISION

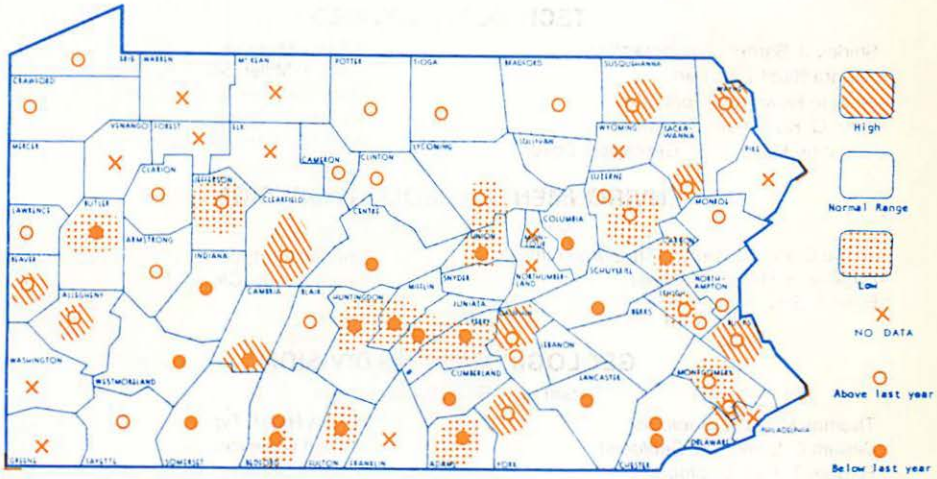
In Cooperation with The U.S. Geological Survey

GROUND WATER DIVISION

In Cooperation with The U.S. Geological Survey

NOVEMBER 1974

GROUND-WATER LEVELS



BUREAU OF TOPOGRAPHIC AND GEOLOGIC SURVEY
DEPT. OF ENVIRONMENTAL RESOURCES
HARRISBURG, PA. 17120