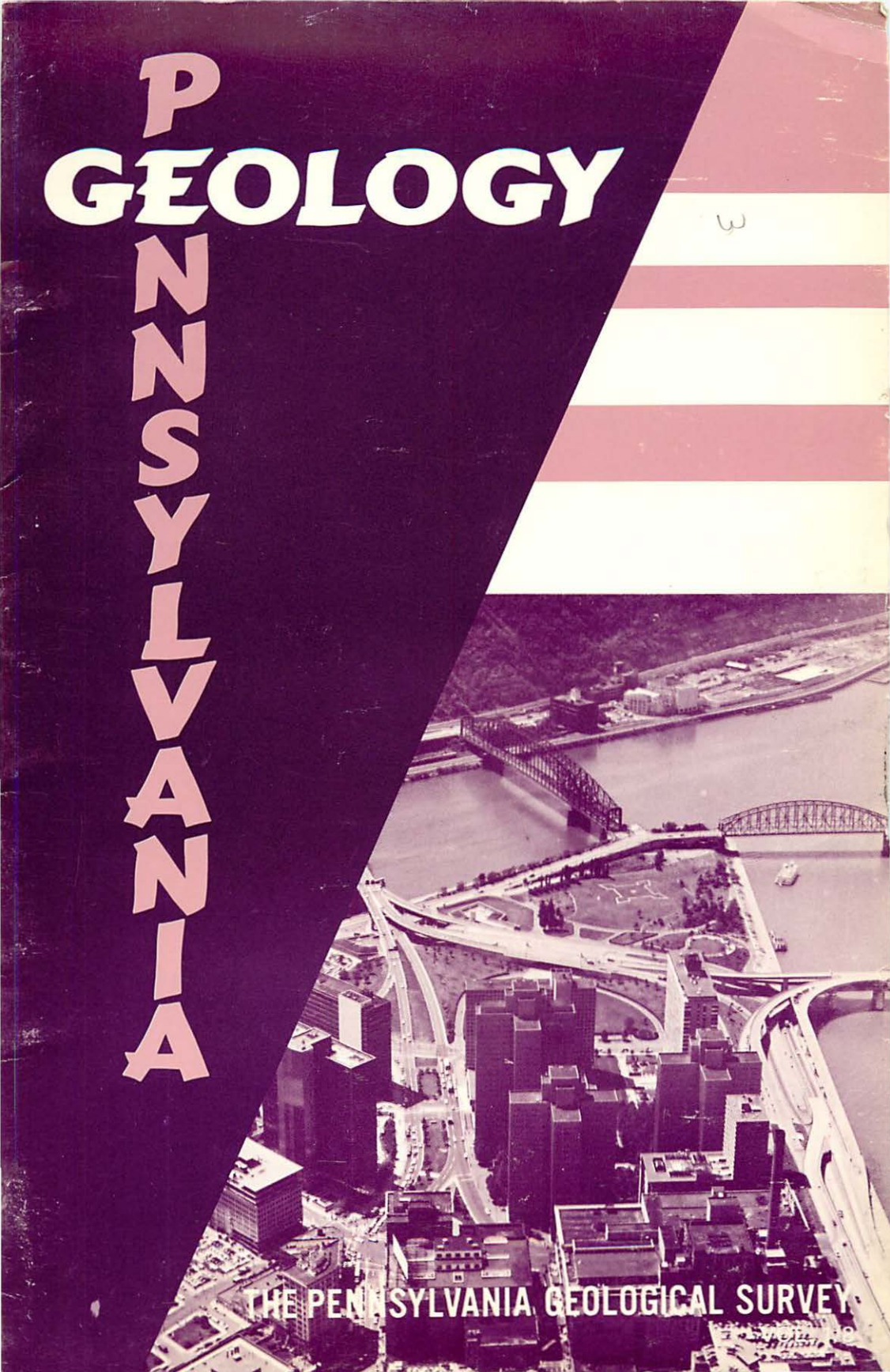
PENNSYLVANIA GEOLOGY



THE PENNSYLVANIA GEOLOGICAL SURVEY

COMMONWEALTH OF PENNSYLVANIA
Raymond P. Shafer, Governor

STATE PLANNING BOARD
Irving Hand, Executive Director

Topographic and Geologic Survey
Arthur A. Socolow, State Geologist

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ON THE COVER—Aerial view of the "Golden Triangle" and downtown Pittsburgh, center of the region covered in the Pennsylvania Geological Survey's new **Geology of the Pittsburgh Area.** Photo courtesy of the Pennsylvania Department of Transportation.

PENNSYLVANIA GEOLOGY is published bimonthly by the Topographic and Geologic Survey, Main Capitol Annex, Harrisburg, Pennsylvania, 17120.

OCTOBER 1970

FROM THE DESK OF THE STATE GEOLOGIST . . .

GEOLOGY FOR ALL!

In this issue we are announcing the publication of the Survey's Latest book, **GEOLOGY OF THE PITTSBURGH AREA.** With the growing interest of man in his natural environment, with thousands of Pennsylvania children taking courses in Earth Science, and with geology becoming a household word thanks to our lunar astronauts, we believe a well written, nontechnical, illustrated report on local geological features will be utilized by a wide audience.

Certainly the Pittsburgh Area offers a choice environment of geologic features and a history greatly influenced by geology. The very development of that great steel center is due to the presence of vast coal and limestone resources needed for steel-making furnaces. The great Monongahela, Allegheny, and Ohio Rivers have served as major arteries of transportation. The sharply rolling topography has resulted in natural and man-made cuts which have exposed great thicknesses of rock layers visible to every resident of the Pittsburgh Area.

At the Survey office we have been receiving a growing number of requests from all over the State for geologic field trip guides and for explanations of geologic features observed by travelers. People are asking for suggestions where they might travel to see unusual geologic features, and where they might collect various rocks, minerals, and fossils. Schools, scout groups, mineral clubs, summer camps, conservation workshops, and "golden age" groups are all increasingly interested in their geologic surroundings. We are pleased to see this healthy trend and are making every effort to be of assistance. **GEOLOGY OF THE PITTSBURGH AREA** is one such example.

Arthur A. Socolow

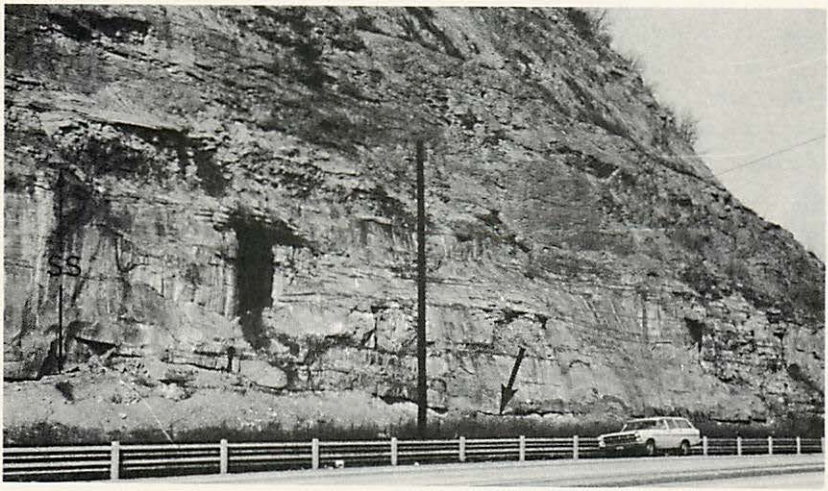
GEOLOGY OF THE PITTSBURGH AREA PUBLISHED

A new guide to geologic features and geologic history of the Greater Pittsburgh Area has been issued by the Pennsylvania Geological Survey. **GEOLOGY OF THE PITTSBURGH AREA** was authored by Walter R. Wagner and other members of the Pennsylvania Survey staff, as well as members of the Pittsburgh Geological Society.

The 145-page, well-illustrated book presents a description and interpretation of the geology in and around Pittsburgh with emphasis on specific localities that the reader may readily visit. A county locality map in the book will help to plan field trips to the points of interest. The localities were carefully selected to illustrate basic principles of geology. The role of geology in the historical and economic development of Pittsburgh is covered in the sections dealing with soils, landslides, mine subsidence, and mineral resources.

GEOLOGY OF THE PITTSBURGH AREA will be of interest to a wide range of readers. The general public, both adult and of school age will better appreciate the fascinating array of geologic features which are abundantly displayed around Pittsburgh. Earth Science teachers and all interested in environmental features will find the book an excellent outline and guide to Pittsburgh area geology. The glossary, extensive bibliography, detailed diagrams and photographs in the book make it an excellent teaching aid and source book.

GEOLOGY OF THE PITTSBURGH AREA, Bulletin G 59, is available from the Bureau of Publications, P.O. Box 1365, Harrisburg, Pa. 17125, for $1.00 plus sales tax.



Outcrop of Morgantown sandstone (ss) along Kennywood Boulevard. Arrow shows position of basal conglomerate.

DISCONFORMITY EXPOSED

Magnificently exposed in a new road cut at Blue Mountain where Interstate 81 passes through Swatara Gap, about 25 miles northeast of Harrisburg, are vertical beds of sedimentary rock. The relationship between these strata illustrates an important geologic principle. The dark rocks to the left are shales and thin siltstone beds of the Martinsburg Formation of Ordovician age. The lighter colored rocks to the right are quartzites and conglomerates of the Tuscarora Formation of Silurian age. The contact between the two formations is a systemic boundary but in this case it also happens to be a surface of unconformity. An unconformity is a surface of erosion or nondeposition that separates younger strata from older rocks. Where the beds are parallel on opposite sides of the unconformity, as in this instance, it is more properly termed a disconformity. Where older beds below the unconformity are inclined at a steeper angle than the younger strata it is termed an angular unconformity.

An angular unconformity may easily be recognized in a single outcrop because of the difference in inclination of the strata. A disconformity is more difficult to recognize because in a single outcrop strata appear to be part of a continuous sequence. Disconformities are usually recognized as a consequence of a regional study. In this instance it is known that in the southern part of the state two other formations normally occur between the Martinsburg Formation and the Tuscarora Formation and that there is continuous deposition or conformity between these strata. Also, if the Tuscarora Formation, or its equivalents, are traced northeast into New Jersey it is deposited on successively older rocks until ultimately it is deposited with an angular unconformity in Precambrian igneous rocks. This illustrates another important aspect of unconformities—they increase in magnitude toward the edge of a sedimentary basin and towards the center of a sedimentary basin they decrease in magnitude, ultimately passing into conformable strata.

Unconformities are no mere academic curiosity. They have considerable significance in the search for minerals, and as such are mapped and studied in detail. Oil or gas occurs frequently at or near an unconformity surface—indeed

(Continued on Page 9)

SURFACE TO MIDDLE DEVONIAN SECTIONS PLACED ON OPEN FILE

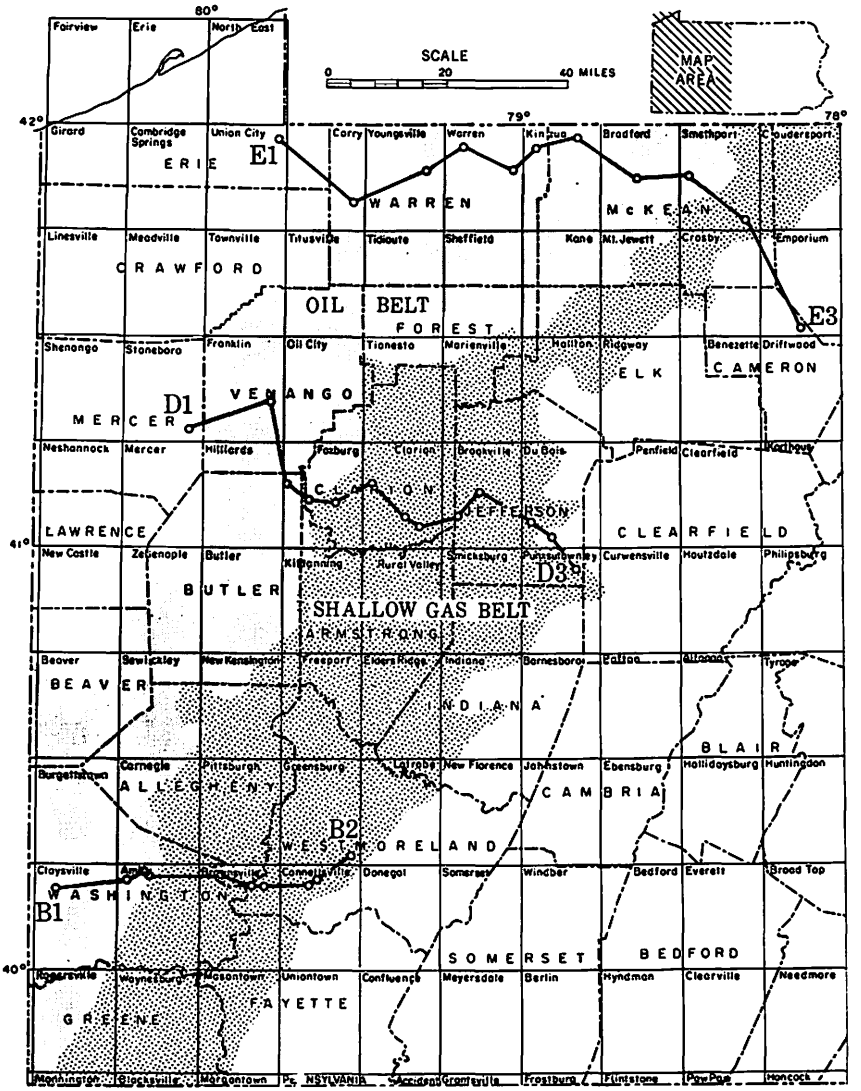
The first three regional gamma-ray log cross sections of the Survey's current study of **Surface to Middle Devonian Economic Stratigraphy** have been placed on open file to make the data of this important project available for immediate use. The location of these initial sections is shown in the figure. Included with the cross sections are an illustration of the regional stratigraphic setting of the sections, and a table showing the position of subsurface names with respect to zones defined in the report. Other cross sections are in progress and upon completion of these, all of the sections will be published together.

The purpose of the cross section is multifold:

1) to establish regionally consistent correlations and to delineate prominent reservoir zones and important changes in thickness and facies,
2) to indicate occurrence of fresh and salt water where reported in the locality of control wells and to mark the position of prominent coals, limestones, clays, and other resources, and
3) to reproduce gamma-ray logs at the same vertical scale (1 inch to 100 feet) as commercially available geophysical and sample logs, thus enabling these sections to be correlated directly with the commercial data.

Because geophysical logs themselves are basic data, they can be used independently of correlations and interpretations. Consequently, the cross sections will afford a basic reference network of geophysical logs for subsurface investigations, whether directed toward oil and gas reservoir distribution, subsurface disposal of effluent wastes, sources for brines or fresh water, potential pollution migration, or the distribution in the near subsurface of other exploitable resources such as coal, clay, limestone, dolomite, aggregate, and other construction material.

The cross sections may be examined in the Pennsylvania Geological Survey office, 401 Pittsburgh State Office Building, 300 Liberty Avenue, Pittsburgh.



MAP SHOWING LOCATION OF CROSS SECTIONS.

COAL ANALYSES AND STRIP MINE DESCRIPTIONS AVAILABLE

The Pennsylvania Geological Survey has placed on open-file more than 700 coal analyses representing samples collected from over 400 sites by staff coal geologists during the summers of 1966, 1967, 1968, and 1969. These surface coal samples were collected from active strip mines throughout the bituminous coal fields of Pennsylvania as part of a continuing program, which is designed to record temporarily available geologic data exposed in strip mines before the mines are backfilled. In addition to coal analyses, a complete description of the rocks exposed in the strip mine highwalls is also available for each site. The highwall descriptions include megascopic data on the coal and other rock types, thickness, color, bedding, sedimentary structures, vectorial features, concretions, fossils, jointing, faulting, slumping and weathering.

Each sample site is plotted on a 7½-minute topographic quadrangle map or on a 15-minute quadrangle where 7½-minute quadrangles are not available. In nearly all cases the operator's identification of the mined coal seam and frequently a staff member's evaluation of that identification is available.

All the coal samples collected before 1969 were analyzed by contracted, independent, analytical firms in 1969 and 1970. Only proximate analyses, sulfur determinations, and BTU (British Thermal Units) values are available for these samples and no attempt has been made to evaluate the effects of long-term indoor storage on the analyses of these samples. For this reason extreme caution must be taken when basing important decisions or conclusions on analyses of the pre-1969 samples. Post-1969 as well as future samples will be analyzed by the United States Bureau of Mines, under a cooperative program with the Survey, as soon after collection as possible. The United States Bureau of Mines is reporting complete ultimate and proximate analyses, BTU values, as well as the initial deformation temperature, softening temperature, and fluid temperature of the ash. The free-swelling index is also commonly reported.

The coal sampling technique used in this Survey program is unique and requires a few words of explanation. Each examined coal seam is separated into as many visibly different or physically separated benches as possible. Each bench is then individually channel sampled and analyzed. A typical coal sample is shown at the top of the next page as an illustration:

Clarion coal sample: 85-C-155

0 -11½ inches	Coal, very shaly (Separate analysis)
11½-22½ inches	Coal, bright (Separate analysis)
22½-23 inches	Bone parting (Not analyzed)
23 -40½ inches	Coal, bright (Separate analysis)
40½-41½ inches	Claystone parting (Not sampled)
41½-50 inches	Coal, bright (Separate analysis)
50 -53½ inches	Claystone parting (Not analyzed)
53½-56½ inches	Coal, bright (Separate analysis)

Composite (0-56½ inches) .... Weighted average of all analyzed benches

In the above example, the coal sample consists of five separately analyzed benches. The composite analysis is a computer-calculated analysis made by mathematically combining the individual bench analyses into a theoretical total seam analysis. The individual-bench sampling method is primarily designed to show the vertical distribution of ash and sulfur in a coal seam and should prove useful in selective mining of low-ash or low-sulfur coals.

Obvious uses for these analyses and highwall descriptions are many and varied. Reserve computation, coal and coal land evaluation, ground-water aquifer potential, excavation and foundation information, clay, shale and other resource exploration, and regional stratigraphic correlation are but a few such uses.

These analyses and highwall descriptions may be examined by appointment at the Harrisburg office of the Pennsylvania Geological Survey, Room 210 (Rear), Old Museum Building, Harrisburg, Pennsylvania, 17120.

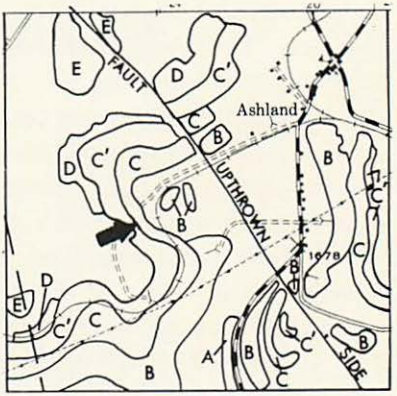
PENNSYLVANIA TOPS IN GAS STORAGE

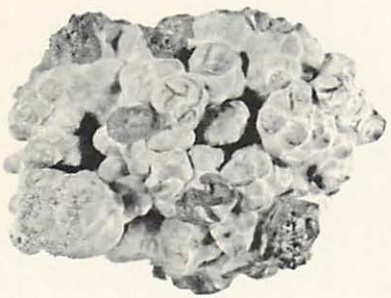
A volume of gas (nearly 5 trillion cubic feet) equal to one-fourth of last year's entire U. S. gas production can now be stored in the 320 natural gas storage reservoirs operated by 80 companies across the United States, according to the American Gas Association. The total output from storage last year was 1.4 trillion cubic feet with 21.6 billion cubic feet withdrawn on the maximum demand day.

The state with the most underground storage reservoirs is Pennsylvania with 63 whose capacities total 707 billion cubic feet. These reservoirs delivered 292 billion cubic feet from storage last year.

LIMONITE CONCRETIONS IN CLEARFIELD COUNTY

LOCATION: This locality is situated in the northwestern corner of the Houtzdale 7½-minute quadrangle in Decatur Township, Clearfield County, about ½ mile southwest of the village of Ashland, Pennsylvania and 2½ miles north of Houtzdale. The limonite occurs just above an abandoned, backfilled strip mine. Permission to collect should be obtained from Mr. L. T. Phillips in the Kittanning Coal Company office at 719 Lingle Street, Osceola Mills, Pennsylvania.





MINERALS:

Limonite: earthy to compact septarian concretions; some botryoidal and stalactitic forms.

Coal: medium-volatile, bituminous; as nearly horizontal seams.

Siderite: nodular and lenticular concretions in shales over several of the coals; concretions often contain sphalerite and quartz crystals, occasionally pyrite and siderite crystals.

GEOLOGY: Nearly flat-lying Pennsylvanian Age (300,000,000 years old) rocks are exposed in six levels of strip mines in this area. These levels correspond to the six minable coal seams that outcrop in the vicinity of Ashland. These seams are listed below in descending order and strip mines on each of them are annotated with letters (A, B, C, C', D, and E) on the location map: Upper Freeport coal (E), Lower Freeport coal (D), Upper Kittanning coal (C'), Middle Kittanning coal (C), Lower Kittanning coal (B), Clarion coal (A).

The intervals separating these seams range between 30 and 70 feet in thickness while the rocks making up these intervening intervals consist of more or less rhythmic alternations of underclay, sandstone and shale with an occasional freshwater limestone. The minable coal seams vary in thickness from a minimum of 24 inches to a maximum of 54 inches. Thin (usually less than 12 inches) "rider" coals occur between several of the major seams and can be seen in the vertical faces (highwalls) of some of the strip mines.

A fault trends diagonally northwest-southeast through the locality area. Relative movement along this fault has caused the northeastern side to rise relative to the southwestern side. For this reason, the strip mines in the upper central portion of the location map show an apparent displacement of approximately 60 feet. In the southeastern corner of the area, the apparent displacement is much greater - on the order of 100 to 120 feet.

At this site, limonite has replaced nodules of freshwater limestone which usually occur in the underclay below the upper Kittanning coal. This replacement is the result of weathering processes. The limonite occurs as irregular to nodular concretions interspersed in a soft, plastic clay and now lying loose along and below the clay outcrop. The concretions are most commonly compact to earthy septarian boxworks although many specimens display botryoidal and stalactitic forms. Similar limonite concretions occur in the underclays beneath the Upper and Lower Freeport coals in this area. All of the strip mines in the area are backfilled except for a few very old ones. Collectors are warned to stay away from the steep strip mine highwalls because of the danger of falling debris and are also cautioned not to damage the seedlings that have been planted in the backfilled areas to reclaim the land. Do not enter any of the abandoned underground mines in the area as they are extremely dangerous and susceptible to collapse.

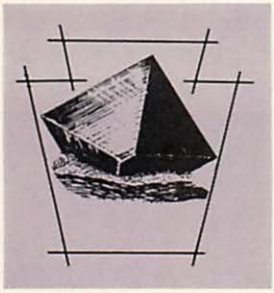
REFERENCE: Edmunds, William E. (1969), **Geology and Mineral Resources of the Northern Half of the Houtzdale Quadrangle,** Pennsylvania Geological Survey, 4th ser., Atlas 85 a-b, 150 p.

Gary B. Glass

(Continued from Page 3)

some of the largest petroleum deposits in the world are so associated. Nonmetallic minerals such as residual high-alumina clays, glass sands, and phosphates frequently are concentrated at unconformities. Some gold and platinum placer deposits and sedimentary uranium deposits are associated with unconformities. There are also instances where ore-forming solutions have migrated along unconformities and formed metallic replacement deposits.

Samuel Root



EARTH SCIENCE TEACHERS' CORNER

STILLWELL QUARRY

The Geologic Survey has received word recently from the owner of this very old and famous quarry that it is closed to mineral collecting. After one serious accident involving loose rock on the highwall of the quarry, the owner has closed the quarry to everyone. Please pass this word along to your students if they "dig" this quarry.

"WHERE CAN I FIND . . .?"

A very timely article on resources and references in the earth sciences appeared in the September 1970 issue of the Journal of Geological Education. Now that another school year has started, I am sure that many of you are asking this same question. Charles and Janet Wall of the Science Department of McFarland High School in McFarland, Wisconsin have written this impressive list of resources and references in the hope that new avenues of earth science materials will be opened. Contact any member of the National Association of Geology Teachers and ask to borrow his copy of the September Journal.

NEW MOON MINERALS

Armalcolite is a new mineral found in moon rocks returned by the Apollo 11 expedition. It was named in honor of Neil **Arm**strong, Edwin **Al**drin and Michael **Col**lins. Armalcolite crystallizes in the orthorhombic system, is an oxide of ferric iron, titanium, and magnesium, and resembles the Earth mineral pseudobrookite. It occurs in lunar basalts as minute, black, opaque grains.

Another mineral found in the Apollo 11 rocks is pyroxferroite, a close relative of the pyroxene minerals so common in earthly basalts. To date, pyroxferroite has not been found on the Earth. It occurs as small yellow grains and is essentially a ferrous silicate.

In general, the moon rocks so far examined are similar to terrestrial basalts. There are some minor chemical differences, however, such as higher concentrations of titanium, zirconium, and the rare-earth elements. There also is very little of the oxidized form of iron, ferric iron.

QUARTZ ROSES FOR YOUR ROCK GARDEN

An unusual form of quartz has been found recently in the Mechanicsburg area. The specimens seem to have a crude rosette structure, also sometimes referred to as "cabbage head" quartz.

A quick search of the literature turned up some mention of this occurrence locally but nothing on this "structure" of quartz could be found in standard mineralogical references. "Rosette chert" has been reported occurring at the top of the Rockdale Run Formation of the Beekmantown Group by Stose (1909, p. 7), Sando (1957, p. 24), and Root (1968, p. 31). The upper part of the Rockdale Run Formation typically consists of a fine-grained, mechanical limestone with numerous dolomite laminae. Although not seen in outcrop by the author, numerous pieces have been collected from the residual clayey soil at the horizon of the upper part of the Rockdale Run Formation in an abandoned stream channel near Mechanicsburg. The appearance of this material in float can be used as a mapping clue to this formation where outcrops are not available.

The photograph clearly shows their typical structure. Most "rosettes" are imperfectly developed. Where they are well developed, the quartz can be seen to have a banded, concentric structure, sometimes arranged around a small, spherical quartz core. The quartz in the bands is milky and the grains so small that they can be seen only with a high-power microscope. The "rosettes" usually completely encircle a specimen. For this reason, it is believed that they are not silica replacements of algal colonies. Such colonies have a definite growth pattern that is convex upward. Furthermore, slices made through groups of rosettes failed to show any of the regular structures characteristic of algal colonies.

Cut slices of rosette groups revealed that the inside of such a group contains rounded clear quartz grains in a matrix of hematite and limonite. All of this material occurs between rosettes. The two iron minerals strongly suggest that the quartz grew after (or perhaps during) oxidation or weathering. Thus, the rounded, probably detrital, clear quartz and the iron oxides are believed to have been included by the growing quartz rosettes. The colloform structure of the quartz rosettes also signifies growth from a colloidal silica gel at the low temperatures characteristic of surface weathering conditions. Such conditions prevent the growth of large quartz crystals.

Further investigation of these unusual mineral specimens is underway. Still unanswered is the ultimate source of the quartz (it occurs in a limestone) and how long after the initial limestone was lithified into rock the quartz rosettes began to form.

REFERENCES

Root, S. I. (1968), **Geology and Mineral Resources of Southeastern Franklin County, Pennsylvania,** Pennsylvania Geological Survey, 4th ser., Atlas 119cd, p. 30-33.

Sando, W. J. (1957), **Beekmantown Group (Lower Ordovician) Maryland,** Geol. Soc. America Memoir 68, 161 p.

Stose, G. W. (1909), **Description of the Mercersburg-Chambersburg District, Pennsylvania,** U. S. Geol. Survey Atlas, Folio 170, 19 p.

William H. Bolles
Pennsylvania Department of Education

Davis M. Lapham
Pennsylvania Geological Survey

FOSSILS FROM "DOWN UNDER" FOUND IN PENNSYLVANIA

Fossils similar to very ancient "jelly fish" discovered in South Australia have been found in Pennsylvania by Professors Helgi Johnson and Steve Fox, Jr. and students of the Department of Geology of Rutgers, New Brunswick, New Jersey.

The soft-bodied, jelly-fish-like fossils were first found in Australian rocks over 560 million years old. Until the Pennsylvania discovery no other specimens similar to these had been found, The Pennsylvania specimens were found in the Delaware Water Gap in shale layers of the Shawangunk Formation which is 425 million years old.

The new discovery extends the time range of these unusual fossils from before the Cambrian Period to the Silurian Period and in areas from Australia to Eastern North America.

Artist's sketch of "jelly-fish" (Genus Rutgersella) from Pennsylvania

SURVEY ANNOUNCEMENTS

ANNUAL OIL AND GAS REPORT

Progress Report 181, **"Oil and Gas Developments in Pennsylvania in 1969 with Ten-Year Review and Forecast"**, has recently been published by the Pennsylvania Geological Survey. The report is divided into four parts: Part 1, Completion Highlights for 1969; Part 2, Oil and Gas Industry Activity in 1969; Part 3, Summarized Records of Deep Wells Reported in 1969; Part 4, Ten-Year Review and Forecast.

Oil and gas developments in 1969 were highlighted by a number of significant developments. Drilling and production of oil increased 16 and 7 percent, respectively. Production and reserves of gas declined during the year.

A major aspect of the 1969 annual report is the Ten-Year Review and Forecast. Of particular interest is the demonstration of the large volume of untested sediments in Pennsylvania and the projection for continued development of gas reserves and production.

Progress Report 181 may be purchased from the Bureau of Publications, P. O. Box 1365, Harrisburg, Pa. 17125, for $0.70 plus sales tax.

KINZUA REPORT PUBLISHED

The Pennsylvania Geological Survey has just published Bulletin M 62, **"Oil and Gas Geology of the Kinzua Quadrangle"**, by W. S. Lytle and J. H. Goth. This report gives the results of a detailed investigation of the oil and gas resources of the Kinzua quadrangle of Warren and McKean Counties. It shows which formations are productive of oil and gas and what their physical and chemical properties are. Included are a description of the oil and gas fields and a discussion of future oil and gas possibilities of the area.

The report contains descriptions resulting from microscopic examination of each of the reservoir rocks. Average thicknesses of the reservoir rocks and thickness changes from one place to another are shown. The history of the oil and gas industry of the area is reviewed and current activities are noted. Local drilling and production practices are also discussed.

A detailed map of the oil and gas fields shows the locations of over 1600 wells drilled for oil and gas in the Kinzua quadrangle. Other maps show the

structures in the quadrangle and the thickness of two of the productive horizons; three detailed cross sections correlate the producing sandstones.

This report will be of use to the oil and gas operator, to the professional geologist, to planners in the area, to highway and construction engineers, and to students of geology and oil and gas history. Oil and gas operators and professional geologists desiring to develop the area, operate secondary recovery projects, or explore for new oil and gas will be able to use large portions of the data to assist their activities. Planners and those engaged in construction will need to know the locations of the active and abandoned wells and will have to be aware of areas where consideration should be given to valuable oil and gas property. Students of geology and oil and gas history will better understand the oil and gas geology of the area and the events during the early days of oil.

The authors conclude that some of the old oil productive areas should be amenable to secondary or tertiary recovery methods and that large areas exist where only limited exploration has taken place. Extension of several of the old oil and gas fields is also possible. It is hoped that this report will stimulate the oil and gas operators to continue to develop and to prospect for new production.

Bulletin M 62 is available for $5.00, plus sales tax, from the Bureau of Publications, P.O. Box 1365, Harrisburg, Pa. 17125.

FRANKLIN COUNTY REPORTS

Two publications dealing with the geology of the carbonate rocks in Franklin County have just been published by the Pennsylvania Geological Survey.

Progress Report 179 by Angelo O'Kuma entitled **Geology of the Carbonate Rocks of Path Valley, Franklin County, Pennsylvania,** shows the distribution of the various formations that comprise the large belt of carbonate rocks in Path Valley in the northwestern part of the county. The carbonate rocks of Ordovician age form a single large anticline faulted on the west side and surrounded by younger shales. This is presented on a geologic map at a scale of 1:62,500. Progress Report 179 is available for $1.20 plus sales tax from the Bureau of Publications, P. O. Box 1365, Harrisburg, Pa. 17125.

Progress Report 180 by John H. Clark entitled **Geology of the Carbonate Rocks in Western Franklin County, Pennsylvania,** includes the geology of an area extending nearly twenty miles north from the Pennsylvania-Maryland boundary. Three belts of carbonate rocks occur in the region. Each belt consists of a complexly faulted anticline of Cambrian to Ordovician carbonate rocks

surrounded by younger shale. Some of the faults have displacements of several thousands of feet. The distribution of the various formations, folds, and faults is shown on a geologic map at a scale of 1:24,000. Progress Report 180 is available for $1.50 plus sales tax from the Bureau of Publications, P. O. Box 1365, Harrisburg, Pa. 17125.

Each publication includes a brief text that describes the stratigraphy, structure and economic resources of the area. Some of the Middle Ordovician limestones are quite pure and constitute a valuable mineral resource. These reports should be of interest and use to geologists, planners, mineral producers, and conservationists.

NEW OIL AND GAS BASE MAPS

The Survey's new Oil and Gas Base Map Program (Pennsylvania Geology, Vol. 1 No. 4) has been well received. Demand for the initial four base map areas has exceeded expectations. Since first announcement in the February, 1970 issue of this booklet, initial printing of the base plus field outlines for all four maps was exhausted by the end of May. Because of the popularity of the base plus field outlines, the Survey will limit subsequent printing to this series only.

Six-month updated (posted date June 1, 1970) prints of current bases are now available. In addition, prints of three new base maps can be obtained. Available base maps now include:

Designation	Quadrangles Encompassed by Mapped Area
Map 16	Corry, Tidioute, Titusville, Youngsville
Map 17	Kane, Kinzua, Sheffield, Warren
Map 18	Clarion, Foxburg, Oil City, Tionesta
Map 19	Brookville, DuBois, Hallton, Marienville
Map 21	Zelienople, Butler, Sewickley, New Kensington
Map 22	Kittanning, Rural Valley, Freeport, Elders Ridge
Map 23	Smicksburg, Punxsutawney, Indiana, Barnesboro

Paper prints of the bases with field limits can be obtained by writing to the Pennsylvania Bureau of Publications, P. O. Box 1365, Harrisburg, Pennsylvania 17125. Cost of each map is $0.50, plus state sales tax. A check for the appropriate total amount made out to the Commonwealth of Pennsylvania must accompany the order. When ordering please specify the map number.

An index showing the location of the completed bases may be obtained upon request from the Pittsburgh Branch of the Pennsylvania Geological Survey, 401 Pittsburgh State Office Bldg., 300 Liberty Ave., Pittsburgh, Pa. 15222.

NEW SURVEY PUBLICATIONS

The following list of publications has been released by the Survey during the past few months. All of these publications are available at the Pennsylvania Bureau of Publications, P. O. Box 1365, Harrisburg, Pennsylvania, 17125. Checks should be made payable to the Commonwealth of Pennsylvania. For Pennsylvania addresses, please add 6% State Sales Tax. For free publications write to the Pennsylvania Geological Survey, Main Capitol Annex, Harrisburg, Pennsylvania.

Publication			*Price*
A	157d	**Geology, Mineral Resources and Environmental Geology of the Palmyra Quadrangle, Lebanon County,** by A. R. Geyer (46 p., 17 figs., 1 pl.).	$ 2.50
C	67	(Reprint) **Geology and Mineral Resources of York County,** by G. W. Stose and A. I. Jonas (195 p., 14 figs., 38 pls.).	10.00
G	59	**Geology of the Pittsburgh Area,** by W. R. Wagner and others (145 p., 65 figs., 4 pls.).	1.00
IC	69	**The Mineral Industry of Pennsylvania in 1968,** by C. C. Yeloushan (22 p., 2 figs.).	Free
Map	20	**Water Yielding Capability of Bedrock Units** (1 sheet 9" x 12" in color)	Free
M	62	**Oil and Gas Geology of the Kinzua Quadrangle,** by W. S. Lytle and J. H. Goth (99 p., 11 figs., 9 pls.).	5.00
M	64	**Proceedings: Fifth Forum on Geology of Industrial Minerals,** edited by K. V. Hoover (278 p.).	2.35
PG	4	**Moraine State Park,** by W. S. Lytle (7 page leaflet, 3 figs.)	Free
PR	179	**Geology of the Carbonate Rocks of Path Valley, Franklin County,** by A. Okuma (1 plate).	1.20
PR	180	**Geology of the Carbonate Rocks in Western Franklin County,** by J. A. Clark (1 plate).	1.50
PR	181	**Oil and Gas Developments in Pennsylvania in 1969, with Ten-Year Review and Forecast,** by D. R. Kelley and others (65 p., 16 figs.).	0.70
W	27	**Ground-Water Resources of the Loysville and Mifflintown Quadrangles, South-Central Pennsylvania,** by H. E. Johnston (96 p., 12 figs., 2 pls.).	3.40

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