

# **P GEOLOGY**

# **N N S Y L V A N I A**

**THE PENNSYLVANIA GEOLOGICAL SURVEY**

**VOL. 3/5**



# COMMONWEALTH OF PENNSYLVANIA

Milton J. Shapp, Governor

## DEPARTMENT OF ENVIRONMENTAL RESOURCES

Topographic and Geologic Survey  
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ON THE COVER — a panoramic view of the East End Open Pit at Cornwall, Pennsylvania. This is the last operating mining unit at Cornwall. After 200 years of continuous operation, the Cornwall mines will shortly be closed down. Old miners village appears in background. *Photo courtesy Bethlehem Mines Corporation*

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OCTOBER 1972

FROM THE DESK  
OF THE  
STATE GEOLOGIST . . .



### OUR LIBRARY NEEDS

The library of the Pennsylvania Geological Survey, as many of you are aware, was 99.9% destroyed in the flood of June 21 - 24, 1972. We are now in the process of rebuilding. While the library was originally designed as a research reference library primarily for the professional staff of the Survey, over the past few decades it has also functioned as a public library open to anyone needing geological information on Pennsylvania and the United States.

We intend to rebuild our library to be one of the best available geological research libraries with emphasis on the geology of Pennsylvania and the immediately surrounding states. To this end, we will attempt to obtain all known publications on the geology of Pennsylvania. We also intend to obtain complete runs of the publications issued by the State Geological Surveys that border on Pennsylvania. We will also regain complete runs of the major geological periodicals and the publications of the United States Geological Survey. We plan also to house selected publications, primarily of a topical nature, of other states and foreign countries. For general reference, we will obtain a broad range of representative and up to date textbooks of all of the major sub-disciplines of geology.

Many of the early publications will be difficult to obtain. For these we will from time to time issue requests for assistance in finding certain publications. Following is a beginning list of some of our older publications needs.

1. Geological Map of Pennsylvania, 1858 by H. D. Rodgers issued with the 2 (two) volumes set of "The Geology of Pennsylvania, a government Survey" in a slip case bound similar to text volumes.
2. Geological Map of Pennsylvania, issued with Atlas Final Summary Report of the Second Pennsylvania Geological Survey, 1855.
3. Geologic Map of Pennsylvania, 1931 by Stose and Lungstedt.
4. Transactions of the Geological Society of Pennsylvania, 2 (two) volumes issued in 1835.
5. Grand Atlases of the Second Pennsylvania Geological Survey bound in 6 (six) large black portfolios.
6. Miscellaneous Papers Nos. 1 - 6 of the Fourth Geological Survey, all by G. H. Ashley.
  - a. The Story of the Survey, 1920.
  - b. The Work of the Survey, 1923.
  - c. Administrative Report, 1931.
  - d. The Resources of Pennsylvania in a Nutshell, 1931.
  - e. Fifteen Years, September 1, 1919 to September 1, 1934.
  - f. A Quarter Century of Progress.

Arthur A. Socolow



# CORNWALL: THE END OF AN ERA

## Introduction

All of us knew that the ore at Cornwall would one day be exhausted. The end was in sight, but Hurricane Agnes accelerated the process. Loss of power during the hurricane caused the water pumps to shut down. The mines rapidly began filling up with water, submerging pumps in the process. By the time power was returned, it was too late. Dewatering to mine the remaining underground magnetite iron ore would have been too costly to continue. Thus, the eastern and western mines were closed. Only the small east-end open pit remains and its life span is short, considerably less than a year. Then the ground water will move in inexorably, finally, to fill the open pits and submerge this unusual historic, economic, and mineralogic deposit. We shall witness the end of a long and fascinating chapter in the history of our state and nation.

## History

The beginning of operations at Cornwall in Lebanon County, Pennsylvania are shrouded in the past of America's early history, - indeed in its pre-Revolutionary War decades. It is known that Peter Grubb began prospecting in the 1730's in what now is northern Lancaster County. His father had come to America in 1679 and settled along Brandywine Creek ("Grubbs Landing") to become a "native" Pennsylvanian. Peter discovered ore at the present site of Cornwall outcropping on three hills, Big Hill, Middle Hill, and Grassy Hill. In 1734, he purchased 300 acres from William Allen for 135 pounds, an acreage originally owned by the three sons of William Penn. Four years later he purchased an additional 142.5 acres and built the Hopewell forges on Hammer Creek six miles south of the ore deposits. In 1742, Peter Grubb built a charcoal furnace at Cornwall and named it "Cornwall Furnace" after the English mining county where his father was born. This date, 1742, is the usually accepted date for the beginning of mining at Cornwall, - 230 years ago.

From 1742 to the present there have been many owners and the mines have participated in a large share of this nation's critical history. For example, in 1777 Hessian prisoners were pressed into service at \$0.60 per day to make shot, shells, and cannon for the Continental Army. In every succeeding war, and more importantly for the industrial uses of iron and steel, the magnetite iron ore of Cornwall has played a significant role. History also is recorded by photographs of black slaves toiling in the open pit in pre-Civil War days, by mule and horse-drawn ore carts, by early steam-driven percussion drills, narrow-gauge rail haulage, and a myriad of other mementos of our changing past.

In 1786 Robert Coleman from Ireland became a part owner with Peter Grubb the Third. In 1856 the Cornwall Furnace was rebuilt and can be seen today in restored condition as a Museum operated by the Commonwealth of Pennsylvania. In 1883, the last cast was made from this furnace built by Peter

Grubb. From a multitude of ownerships such as the Robeson Iron Co., The Pennsylvania Steel Co., and The Cornwall Ore Bank Co., Bethlehem Steel Corp. began acquiring ownership, completed in 1926. With a concentrator at Lebanon later replaced by a pelletizing plant at Cornwall, two major underground ore bodies, the large open pit, and several smaller open pits, the Cornwall ores have been in continuous production for 230 years and have provided work and yielded products that have contributed mightily to the development of both state and nation. Not only the economic history but also our architectural history at Burd-Coleman and Miners villages is well represented by Cornwall. It is a landmark of the past whose importance continued its growth to the present time.

### **Economic and Geologic Importance**

Ore production of magnetite was all from open pit mining through 1900, by which time more than 18 million natural net tons had been processed. In 1921 a three-compartment shaft was sunk beneath the open pit and in 1927 development was begun of an eastern ore body that had been discovered in 1919 by geophysical exploration. All three major ore bodies continued in production until the closing of the open pit in 1953. In later years, the eastern mine was the major producer. Production will close with an open-pit operation at the east end of the original open pit. Total production since 1742 probably will exceed 100 million tons of iron ore.

In addition to iron ore from magnetite, Cornwall has yielded many valuable by-products. Among the most notable have been copper from chalcopyrite (native copper was found near the surface in the early days of mining), cobalt from pyrite, gold and silver from chalcopyrite, and sulfur from the sulfides. Waste rock, particularly host limestone, has been used for road aggregate and fill. It is interesting to note that the cobalt from Cornwall has represented the only U.S. cobalt production east of the Mississippi River. As much as 1700 ounces of gold have been produced in one year at Cornwall. The iron ore grade averaged 40 - 42 per cent iron before pelletization. Copper in the copper sulfide concentrates generally ranged between 25 and 30 per cent copper. Cobalt averaged more than 1.0% in the pyrite concentrates. The fact that the ores were essentially lacking in phosphorous and titanium has also been of benefit to mining here.

The ores were first investigated geologically in 1858 by the Pennsylvania Survey's first State Geologist, Henry Rogers, followed by studies by other Survey geologists, including Lesley and d'Inwilliers, Spencer, Hickok, Gray, Lapham, and many others. The deposit has attracted geologists for over 100 years because it is very nearly unique outside of Pennsylvania: magnetite associated with diabase. Spencer coined the term "ore deposits of the Cornwall type" to represent them and Lindgren in his famous classification used this deposit as representative of his "pyrometasomatic" ore deposits. Much of the recent work has been done by the Pennsylvania Geological Survey and a

publication on Cornwall by Lapham and Gray is in press. Theories of origin have ranged from remobilized sedimentary iron through many ingenious magmatic explanations. The latter are generally accepted today, the principal discussion being whether the magnetite originated directly from the underlying diabase, as Spencer and Lindgren believed, or from an underlying magmatic source which also had been the source of the diabase. The Survey currently favors this latter explanation. Whichever ultimately becomes accepted, Cornwall certainly has exerted a fascination for geologists, and it probably will continue to do so.

### **Mineral Collecting**

It has been almost literally an era in the geological sense that Cornwall, Pennsylvania has been a Mecca for mineral collectors from all over North America. Whether Peter Grubb was the first mineral collector in 1742 we shall probably never know, but certainly it was his curiosity and mineral knowledge that brought Cornwall into being. Since that time, many thousands, perhaps hundreds of thousands, of collectors have poured over the famous dumps, searched the open pits, and even entered the farthest recesses of the underground mines in their unremitting hunt for unusual and fine mineral specimens among the nearly 100 species known from there. And they have been amply rewarded as fine collections throughout the world can attest. Now, all this too is at an end.

Because of the premature closing of the underground operations resulting from Agnes, freshly dumped material is no longer available to mineral collectors. Although this may seem a near disaster to amateur and professional mineralogists, we all are in the debt of Bethlehem Steel Corporation for their wonderfully cooperative policy in allowing us enthusiasts to collect there. Few companies in the history of mining have been so gracious. We owe them a vote of sincere thanks.

In the meantime, preserve your Cornwall specimens with care. Make sure they are well labeled. If you have extra specimens contact the Pennsylvania Geological Survey or a museum such as the William Penn Memorial Museum in Harrisburg. Good Cornwall specimens should be where they will benefit the largest number of people and a museum is an excellent final resting place for the remarkable and beautiful minerals that Cornwall has produced.

### **Acknowledgements**

The Pennsylvania Geological Survey is grateful to many staff members of Bethlehem Steel Corporation for supplying information on Cornwall and for permitting its release. We particularly wish to acknowledge Dr. Gilbert Hole, Chief Geologist, and Messrs. Biemesderfer, Olsen, Shale, Sims, and Peets for their assistance and for some of the accompanying photographs.

## **General References**

Gray, Carlyle and Lapham, D. M. (1961), Guide to the geology of Cornwall, Pa. Geol. Survey 4th Ser. Bull. G-35.

Lapham, D. M. and Geyer, A. R. (1969), Mineral Collecting in Pennsylvania, Pa. Geol. Survey 4th Ser., Bull. G-33, 3rd edition.

## **INTERESTING FACTS ABOUT THE CORNWALL MINES**

Prospecting in the area began about 1730 on a tract of land granted by William Penn "for as long as grass grows and water runs:" Magnetite ore was discovered in 1732 by Peter Grubb on three hills in the area.

In 1737 the Hopewell forges were built on Hammer Creek to smelt the ore and in 1742 Peter Grubb built the first Cornwall Furnace, re-built in 1856. Mining activity continued from 1742 to 1972 and Cornwall thus has become the longest continually operated mine in North America: 230 years.

In 1777 Hessian prisoners labored for \$0.60 per day to provide cannon and shot for the Continental Army.

By 1864 there were 96 separate partial ownerships of the mining area and 6 furnaces. In 1926, Bethlehem Steel Corp. became the sole owner of the mines, ending more than 50 years of competition and litigation over the ores.

More than 100 million tons of iron ore have been removed and the by-products have included gold, silver, and cobalt. For the latter element, Cornwall has been the nation's major producer east of the Mississippi River.

Cornwall, Pa., named for the lead-zinc district of Cornwall, England, preserves some of the nation's best examples of 19th Century stone houses in Miners Village and Burd-Coleman Village, many modeled after their English counterparts.

Minerals obtained from Cornwall grace some of the best mineral collections in the world. At least 95 different minerals are known to occur here.

Many innovations in mining technology were first introduced at Cornwall, including the modified bell system. Mining and exploration reached a depth below the surface of 1225' in the eastern mine.

The Cornwall deposit is representative of a group of Pennsylvania magnetite ore deposits that are unique in origin throughout the world. Thus, Waldemar Lindgren, the famous classifier of ore deposits, used Cornwall to illustrate a type of magmatic-related ores. Beginning with the classic 1908 study by A. C. Spencer, Cornwall has been a Mecca for geologists from all over the world.

During a very minor earthquake in the mid-1960's surficial mud and vegetation entered the underground workings with such force that steel rails were curled up like springs and haulage carts were smashed. The final disaster, though, was hurricane Agnes which allowed the water table to take over man's temporary domain.

D. M. Lapham



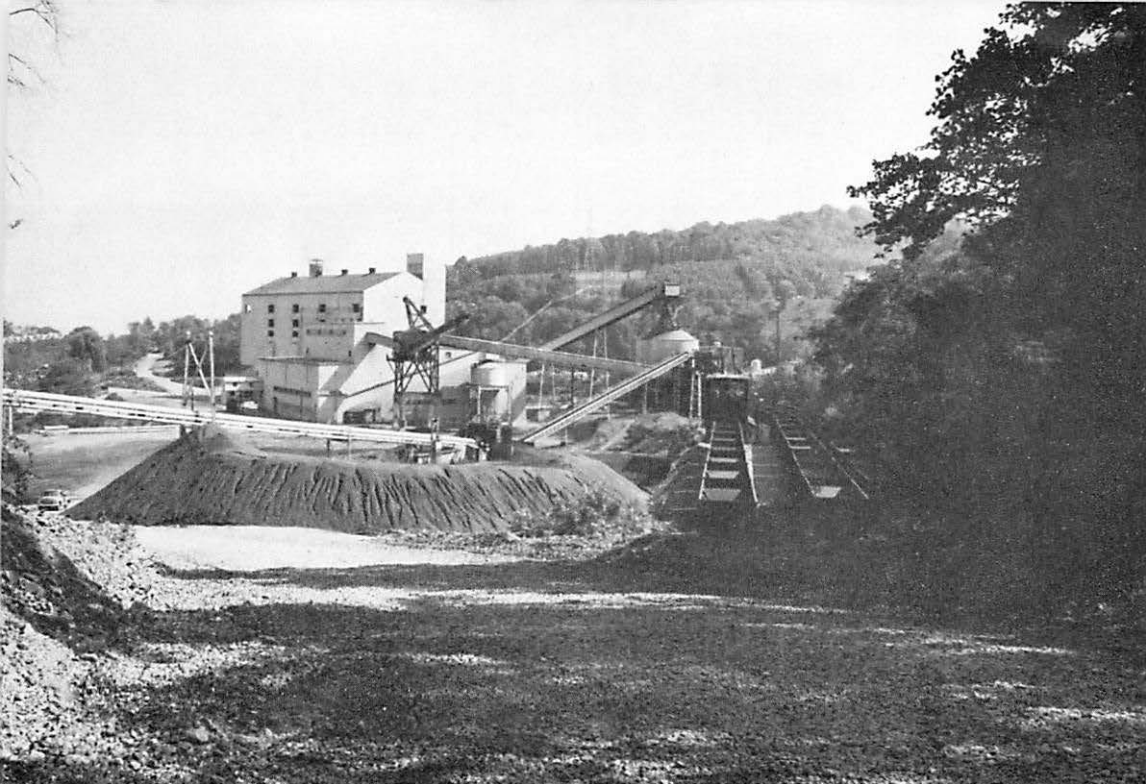
In the Beginning - earliest recorded photo, about 1800, of Cornwall open-pit mine. Equipment and haulage vehicles were simple in those days. Labor costs were held down with use of slaves.

*Photos courtesy Bethlehem Mines Corporation*

View of the new East End open pit mine; still in operation but not for long.



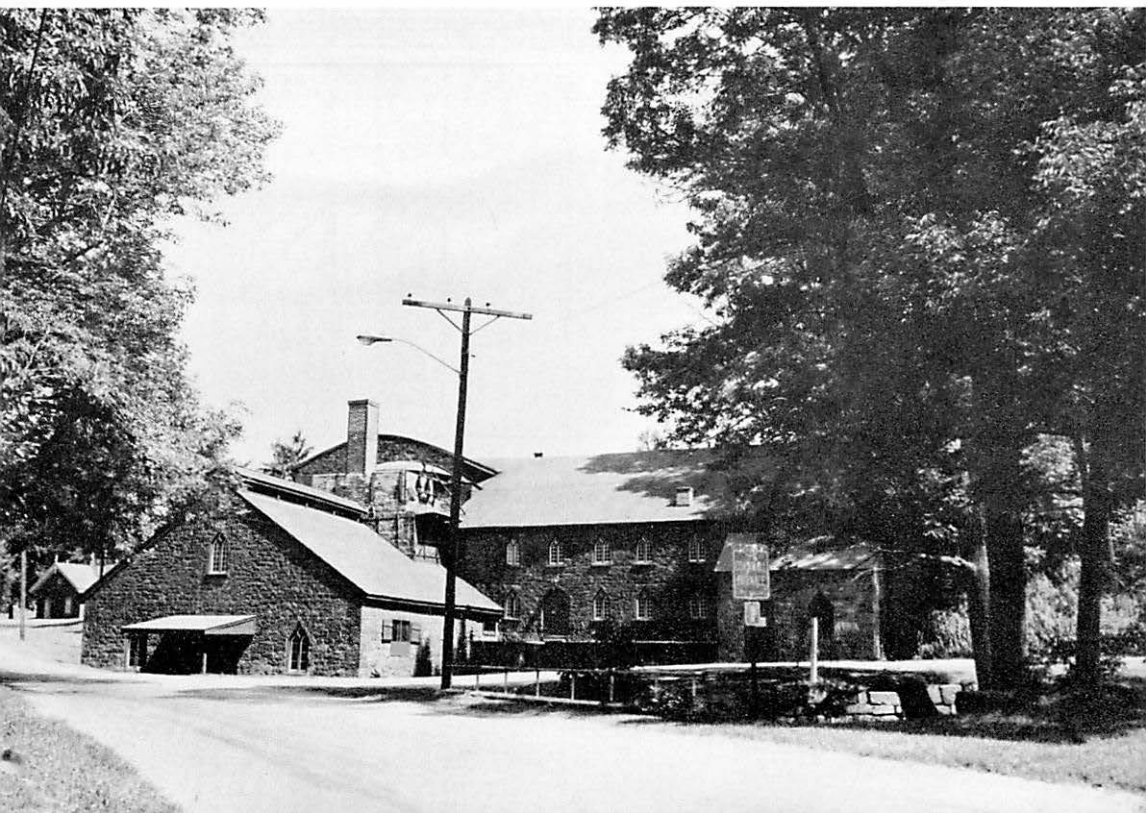




**Cornwall concentrator and pelletizing plant, preparing ore for direct furnace feed.**

*Photos courtesy Bethlehem Mines Corporation*

**Cornwall Furnace, rebuilt and now maintained as a public museum by Pennsylvania Historical and Museum Commission.**





View of main open pit mine, 1952. Ore shows as black zone at base of left wall, with light-colored overlying limestone. Right wall of pit is south-dipping diabase.

*Photos courtesy Bethlehem Mines Corporation*

Heavy equipment in the main open pit, 1953.





Skip bringing up ore on inclined shaft of No. 3 mine, 1952.

*Photos courtesy Bethlehem Mines Corporation*

Panoramic view of Cornwall mines, looking east, 1969. No. 3 mine in left foreground, open pit at center, No. 4 mine in background.





## DOUGHTY MINE, SUNBURY, PA.

Not all of our summer geology assistants spent all of their time cleaning up from the flood, just most of them, most of the time. Taking advantage of the mineral collecting talents of Barrett Borry, now a geology graduate student at Lehigh University, and the cave-mapping and photography experience of Marc Silverman, a senior geology major at LaSalle, the Doughty Mine near Sunbury was mapped and sampled in the middle of August. After four unsuccessful attempts to locate the mine prior to joining the staff, the author and his wife located the mine in early August after obtaining approximate directions from Dr. Allen V. Heyl of the U. S. Geological Survey. Located over a hundred feet up a cliff, the mine entrance was found after walking 10,000 feet of traverses along the hillside. On the previous four trips, a total of an additional 25 miles of traverses were made.

Unwilling to have his wife enter the mine at the same time and unable to use a tape and Brunton compass effectively with the one hand Agnes hadn't put temporarily out of commission, the author ventured through only the first 170 feet of mine workings. At this point a 20 x 5 x 10 foot deep hole in the mine floor was encountered.

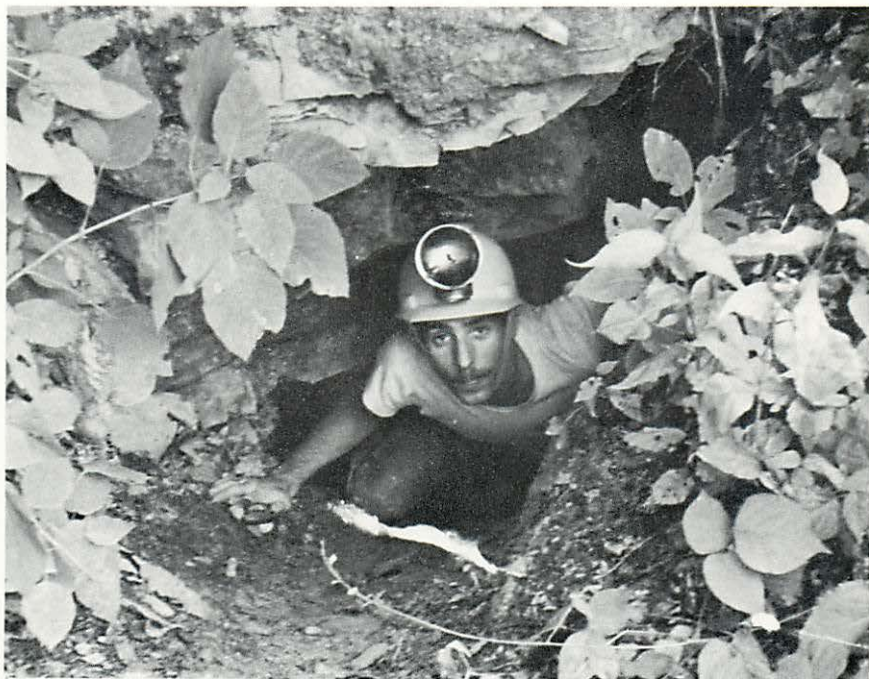


Figure 1. Marc Silverman, experienced in caving (caver) with the National Geographic Society in Puerto Rico, emerges from the Doughty Mine.

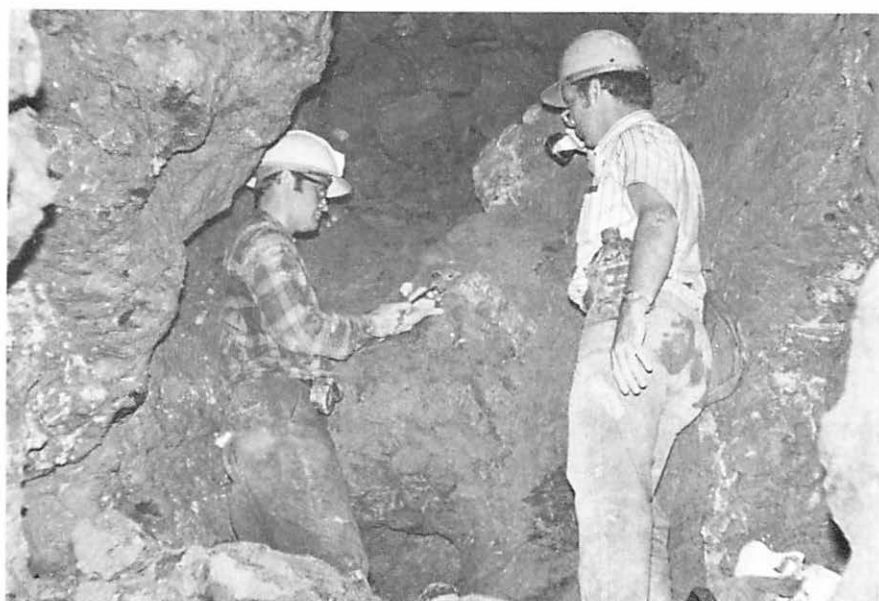


Figure 2. Bob Smith (left) and Barrett Borry (right) sample a hemimorphite - galena vein in the lower level of the mine.

Returning a few weeks later with Messrs Borry and Silverman, the author anticipated that an additional 30 feet of workings might be found, bringing the estimated total to be mapped to 200 feet. After three hours of systematic searching, the total length of possible workings was increased to slightly over 850 feet! In the process, three areas of lead-zinc mineralization were found. One of these was only a 4 inch wide calcite vein with minor galena and hemimorphite, but the other two are a 1 - 2 feet thick vein and a possible replacement bed, both with considerable hemimorphite.

Without the benefit of X-ray diffraction or even a binocular microscope, identifications are uncertain but it appears that galena, hemimorphite (earthy and crystalline), cerussite, angleite, hydrozincite, calcite, and dolomite are present in the mine. Unfortunately, as the mine has only one entrance (less than 2 x 2 feet in size) and portions of the outcrop and mine roof are caving in, the mine must be considered unsafe for mineral collectors.

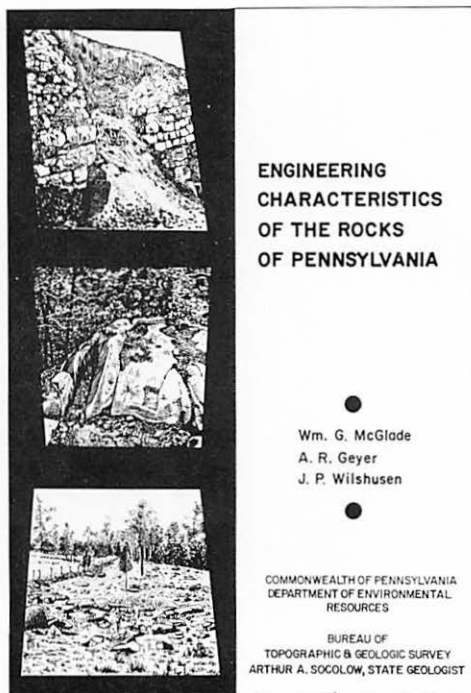
As the main haulage drift now shows traces of former wooden ties, it must be assumed that the mine once had another, more accessible, entrance which is now caved in.

Samples of pure galena from this ore (and all other galena and sphalerite occurrences in the state) will be analyzed for certain trace elements in an attempt to determine if this strata (Keyser-Tonoloway Formation) has potential for economic concentrations of zinc, lead, and silver in Pennsylvania.

Bob C. Smith II

## NEW GEOLOGY HAND-BOOK FOR PLANNERS AND ENGINEERS

Is the bedrock suitable for building heavy structures? What type of construction materials are available from this rock unit? I would like to excavate a large area for a shopping center, how difficult is it to remove bedrock? A new highway is planned, what is the slope stability of the rocks in the area? These and many similar questions may be answered by a new publication just released by the Bureau of Topographic and Geologic Survey, the first publication of its type in the country.



"Engineering characteristics of the rocks of Pennsylvania," Environmental Geology Report No. 1, outlines important engineering, hydrologic, and basic geologic characteristics of rock formations in Pennsylvania. Summarized information is presented in tabular form for each rock unit as described on the State Geologic Map. One of the unique features of this book is the use of over a hundred photos and sketches to visually illustrate the character of each rock unit. This manual is designed to aid in initial investigations of proposed projects. It is broad in scope and will serve as a basis for regional and local land-use planning. EG 1 will provide a ready reference to the overall geometry, engineering behavior, and a visual impression of each rock formation described.

Geology has an important role to play in improving and protecting our environment. Geologic information such as presented in this publication will assist in defining the most effective use of our land and mineral resources. The Bureau of Topographic and Geologic Survey, through emphasis on the relevance of its geologic investigations to the needs of Pennsylvania, is pleased to make this contribution to better environmental planning and development.

Environmental Geology Report No. 1 may be obtained by writing to the Pennsylvania Bureau of Publications, P. O. Box 1365, Harrisburg, 17125. The cost per copy is \$2.50, plus 6% state sales tax.



# **SURVEY ANNOUNCEMENTS**

## **OIL AND GAS PIPELINE MAPS ON OPEN FILE**

The principal crude oil and product pipelines map of Pennsylvania and the principal natural gas pipelines map of Pennsylvania have been brought up to date as of April, 1972. Natural gas distribution lines have been added in some areas where there are no transmission lines. The locations of the natural gas storage fields are also shown.

These two maps are on open file at the following office:

Pennsylvania Geological Survey  
401 Pittsburgh State Office Building  
300 Liberty Avenue  
Pittsburgh, Pennsylvania 15222

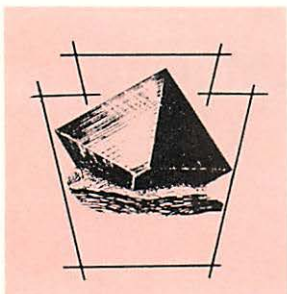
The maps are available for examination at the above office and copies will be made available at the expense of the individual.

## **NEW OIL AND GAS BASE MAP**

A new oil and gas base map, number 36, is now available. The map (scale 1:62,500) takes in the Conrad, Coudersport, Emporium, and Genesee fifteen minute quadrangles covering parts of Cameron, McKean and Potter counties. Paper prints of this map, which shows the locations of all oil and gas wells with records (includes all wells drilled since 1956) in this office with gross field limits, can be obtained by writing to Pennsylvania Bureau of Publications, P. O. Box 1365, Harrisburg, Pennsylvania 17125. Cost of each map is \$0.50 plus 6 percent 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.

IF YOU ARE INCLINED TO DO SOMETHING BAD,  
ARE YOU SYNCLINED?

Terry Wilson



## EARTH SCIENCE TEACHERS' CORNER

### **new pennsylvania earth & space science teachers guide**

A new "Pennsylvania Earth and Space Science Teachers Guide", by the Department of Education, is soon to be released. This book, now in page proof, is to go to press this month, and should be available to teachers before the Christmas holidays.

The new approach to the teaching of Earth and Space Science stresses the philosophy that this is a course for all students. The Bureau of General and Academic Education feels strongly that Earth and Space Science is a course that is of great value to students of all abilities. A stimulation of interest and the ability to relate to the student are placed high on the list of objectives for the guide and the course.

### **NEW TOPOGRAPHIC MAP OF THE GREATER PITTSBURGH REGION**

The Topographic Branch of the U. S. Geologic Survey has recently announced the release of a new topographic map - "The Greater Pittsburgh Region: Counties of Allegheny, Armstrong, Beaver, Butler, Washington and Westmoreland". This full-color topographic map, published at a scale of 1:125,000 with a contour interval of 100 feet, is available with or without the green woodland overprint.

This map is extremely accurate. It represents a series conversion with 7½ minute quadrangle control. It has been completely rescribed and all names adjusted to their proper size. Political boundaries are emphasized by an orange tint. State and county parks, highways by class and type, landmark buildings, airfields, government reservations, cemeteries, lakes, all waterways, dams, locks, flood control and water supply reservoirs are identified by name.

Published as part of the U. S. Geologic Survey's Greater Pittsburgh Regional Studies program, the map is designed to serve as a basis for future projects and for regional and local land-use planning.

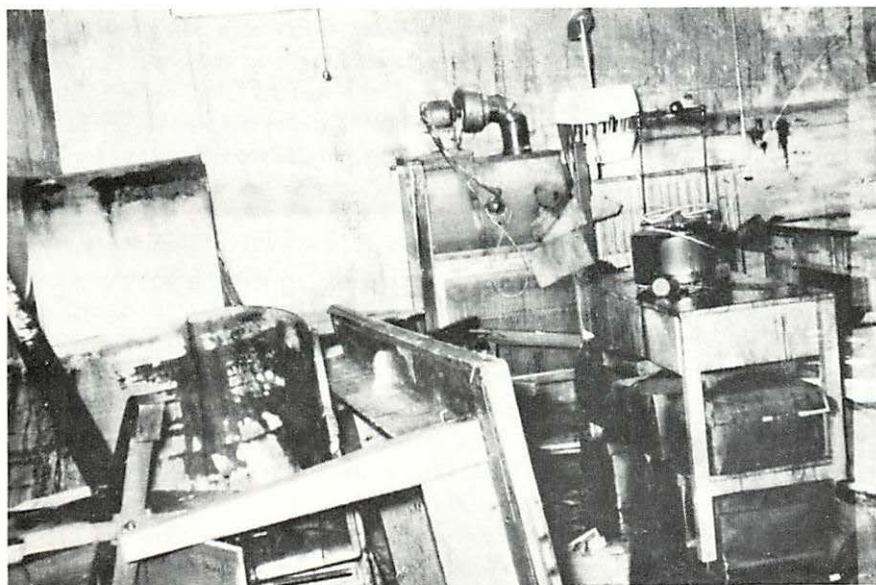
The "Greater Pittsburgh Region" topographic map is available from the Distribution Section, U. S. Geologic Survey, 1200 South Eads Street, Arlington, Virginia 22202. The cost per copy is \$1.75.

## AFTERMATH

Here is the sad account of a laboratory technician's dilemma during the calamity in the immediate days after inundation by Agnes.

Arriving Tuesday morning at the building at 100 North Cameron Street where I worked, I parked my car in what remained of the parking lot. Getting out of the car and surveying the area, the sight was one to inspire awe and disgust. Lumbering over to a group of people and exchanging greetings of the morning, I sensed by the inflections of their voices that they too shared the same emotion.

With everyone attired in old clothes, the area appeared to be invaded by junk collectors carrying out oil-soaked chairs and silt-covered warped desks. I ventured into the building and my first impression was that of being inside a sewer. At my feet was a treacherous mire of what had been ceiling blocks and other debris, oozing with black oil. All around me, up to and including the ceiling, everything was covered with oil. A distinct oil ring was left on the outside of the building, clearly marking the high water level, approximately 12 feet high. The upheaval of furniture demonstrated the angry forces of Nature. With rack and ruin, the flood water took its toll. Weighty cabinets filled with rock specimens were overturned. The offices were left in shambles, as if by the work of vandals. Water-swelled books had wedged so tightly in their bookcases that they had raised themselves off their shelves, making the use of a crowbar or hammer necessary to free them.



Destruction of the Survey's Rock Preparation Lab.



The Chemistry Laboratory had been in the process of being set up prior to the flood, with some of the equipment still in boxes from the big move from the Main Capitol Annex. The boxes now were turned to mush and the contents littered the floor. The X-ray Laboratory with its expensive electronic gadgetry, used only a few short weeks at Cameron Street, now lies dormant and dismembered, waiting to be rejuvenated or replaced. Walking through the hallway, I was astounded to find a sea of books had pushed a partition halfway into the hallway. Peering in from the doorway the heap of books appeared to be at least three feet deep in some spots and seemed to cover the entire floor of the library. The adjacent map room with its overturned map cases was in complete havoc, thousands of maps scattered all over the room. I could go on and on describing what I saw, but space would not allow.

After completing my tour I decided to roll up my sleeves and dig in, but with not much enthusiasm, I might add . . . Where to begin? My first thought was to search for dangerous bottled chemicals that might have floated out of the laboratory or become broken. Canvassing the hallway I found cases of glassware still intact, some distance away from the lab. Manuscripts also were a matter of concern; most were irreplaceable. Finding sheets plastered to the ceiling and other unusual places became 'old hat'. A specific gravity balance was 'pasted' to a wall 5 feet above its normal resting place. For some unaccountable reason one light on each telephone remained lighted although they were dead and all power was off. So it went.

Moving furniture out of the building was a joy all its own. All light was by flashlight. The floor littered with junk and the mire presented a real struggle, especially with the heavier pieces. It was necessary to pry or rip open desk drawers and cabinets in order to retrieve contents. For approximately 2 weeks this recovery operation went on. It was hard, dirty, and sometimes sickening work, due mostly to sewage smells. Now, four months later, order is slowly being restored although months of work remain. Though crippled we are back in business. Like the mythical Phoenix, we shall again rise from the ashes (or more appropriately, the rubbish) to better serve the Commonwealth.

Leslie Chubb

## **NATION USING MORE THAN 370 BILLION GALLONS OF WATER A DAY**

As of 1970, the United States was withdrawing a total of 370 billion gallons of water a day from surface- and ground-water sources to meet the needs of public supplies, commerce, industry, irrigation, and rural users. This amounts to an average of about 1,800 gallons per day per person according to a recently published report of the U. S. Geological Survey.

The report notes that an even greater amount of water, some 2.8 trillion gallons per day, is used to generate hydroelectric power, but is not generally considered part of the Nation's "off-channel" use of water.

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In Cooperation with The U.S. Geological Survey

### GROUND WATER DIVISION

In Cooperation with The U.S. Geological Survey

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U. S. Postage  
PAID  
Harrisburg, Pa.  
Permit No. 1

SEPTMBER 1972  
GROUND-WATER LEVELS

