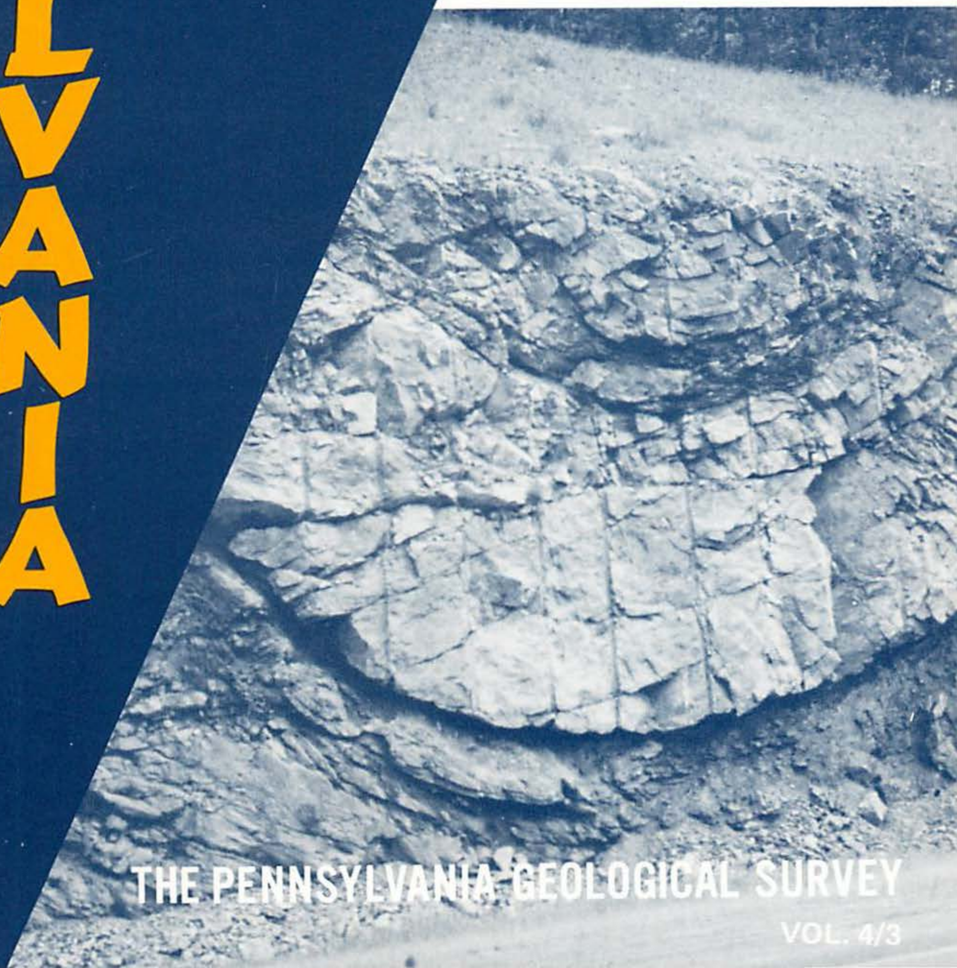
PENNSYLVANIA GEOLOGY



THE PENNSYLVANIA GEOLOGICAL SURVEY

VOL. 4/3

COMMONWEALTH OF PENNSYLVANIA
Milton J. Shapp, Governor

DEPARTMENT OF ENVIRONMENTAL RESOURCES
Maurice K. Goddard, Secretary

TOPOGRAPHIC AND GEOLOGIC SURVEY
Arthur A. Socolow, State Geologist

CONTENTS

ON THE COVER: A striking syncline in the Pottsville Formation along Route 81 near Ravine. Photo courtesy of William Bolles, Pennsylvania Department of Education.

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JUNE 1973

FROM THE DESK
OF THE
STATE GEOLOGIST . . .

OUR OTHER MINERAL RESOURCES ARE ALSO SCARCE

For many months we have been hearing reports on an energy crisis – and there really is one, as the demand for energy of all sources continues to grow faster than the supply of energy from all sources. Now, a new threat to the strength of our economic society has been highlighted as the U. S. Geological Survey has released a comprehensive report showing that for most of our mineral needs, the United States already is a major importer and faces further critical shortages in the next twenty years.

U. S. Geological Survey Professional Paper 820, "United States Mineral Resources" reviews more than 60 mineral commodities which are essential resources in our industrial society and finds that we possess less than half a dozen commercial minerals in major quantities. For the rest, we face fast increasing shortages which will call for (1) even more imports than we have now, (2) revised industrial technology, (3) developing substitutes, (4) increased recycling, (5) intense new exploration, and (6) improved mining and mining technology.

As one looks ahead in the energy "crisis", solutions appear on the horizon in various forms, such as; new oil discoveries, coal liquifaction and gasification, oil shale development, tar sands development, acceptable nuclear energy, geothermal energy, etc.

Ironically, with much less fanfare and ballyhoo about our other minerals shortages, they may actually be much more serious to our society, inasmuch as realistic solutions to their shortages are not on the horizon. Among our existing critical shortages are ores of aluminum, chromium, manganese, mercury, silver, tungsten, asbestos, and nickel. But joining the critical list soon will be lead, zinc, titanium, uranium, barite, high-quality clays, and many others.

While most people can translate energy shortages into personal impacts such as lack of heat or transportation fuel, most persons don't relate to a widespread industrial minerals shortage. Yet the impact of such shortages will be tremendous, ranging from high-priced imports which will seriously affect our balance of payments, to a need to alter and even curtail our voracious, mineral consuming technology as we find ourselves running short of one item after another.

While geologists have been aware of the projected mineral shortages, the U. S. Geological Survey has done a real service in highlighting the problem in Professional Paper 820, "United States Mineral Resources." This 722-page report is available from the U. S. Government Printing Office, Washington, D. C. 20402 for $9.15. A 19-page summary of the big report is available free from the U. S. Geological Survey, Washington, D. C. 20244; it is listed as Geological Survey Circular 682, "Summary of the U. S. Mineral Resources".

Arthur A. Socolow

LAKE ERIE
REACHES RECORD HIGH LEVEL

High water has been a recurring source of problems for Pennsylvanians throughout the history of the Commonwealth, but perhaps never more so than in recent times. Certainly the Great Flood of '72 will go down in history as one of the worst catastrophes ever to strike the Keystone State. This year (1973), attention is focused on the northwestern corner of the state where less destructive, but similarly unequaled high water is taking place along the approximately 45 miles of Lake Erie shoreline in Erie County.

Record high water levels are being recorded on Lake Erie this year. Changes in the lake level are a common event. The level of Lake Erie will normally vary by about one foot in an average year, with the highest water peak in June and the lowest level in February (Fig. 1). In addition to the annual cycle, long term variations can take place (Fig. 2). These do not follow any regular cycle, and reflect long term variations in the amount of precipitation and evaporation in the Great Lakes Region. Since the mid 1960's, when Lake Erie was below normal level, the lake level has been gradually on the rise until, in the first half of 1972, the level was approximately one foot above normal. This situation continued until June, when Tropical Storm Agnes arrived, dumping from 4 to 6 inches of rain along the south shore of the lake. The lake responded to this added runoff by reaching its peak in July, rather than June. Above-normal precipitation continued for the remainder of 1972, bringing about a continued increase in the already above-average lake level. The lowest water for the past fall-winter season came in October, 4 months earlier than usual. Since that time, the lake level has been on an almost continuous rise. A new record has been set for every month since September 1972, and a new all time record high level was set in March of this year, with the lake almost 4.3 feet above the low water datum. The rise is expected to continue until May, when, as of this writing, a level of 4.75 feet above low water datum may be reached. After May, according to the prediction of the Lake Survey Center of the National Oceanic and Atmospheric Administration, a gradual decline should begin until by October it returns to below-record levels.

The rise of the water level by itself does not pose many serious problems. However, when coupled with strong winds, the high levels can be the cause of significant flooding and erosion. The accelerated erosion results from higher than normal waves which are capable to attacking shoreline features with unusual force. These waves are also capable of reaching farther inland than normal, causing damage in areas usually considered to be "safe" from wave attack. Owners of lakefront property are frequently finding their property disappearing before their eyes with each new storm. It is fortunate that most of the Pennsylvania shoreline is protected by bedrock cliffs which range from 50 to 100 feet above the lake level, and which are somewhat resistant to rapid erosion. However, one major feature in Pennsylvania which is in danger due to increased erosion, is Presque Isle, a 6 mile long sand spit which encloses Erie Harbor, and which houses the Pennsylvania State Park at Erie, an important recreational resource in northwestern Pennsylvania. This spit consists of only unconsolidated sand, and is very easily eroded. In addition, much of it is less than 10 feet above the lake level, allowing waves to wash inland a considerable distance, damaging roads and other installations. A storm last January resulted in an estimated $260,000 in damage at the state park. Work was quickly begun to repair the damage and $25,000 to $30,000 had been spent when another storm struck on St. Patrick's Day, proving the repair efforts to have been in vain. Perhaps the greatest danger is that Presque Isle could be severed from the mainland. The French term for peninsula, *"presqu'île"* ("almost [an] island") is especially appropriate for this spit since the outer portion of it is over one mile in width while the near-shore end is only about one-tenth of a mile wide. Erosion along the narrow section has long been a problem, and with this year's record lake level, it is of particular concern to residents of the Erie area.

The problem of flooding occurs as a result of a tilting of the lake level caused by strong, sustained winds. This effect is most noticeable at the eastern and western ends of the lake. A simultaneous difference in lake level of as much as eight feet has been recorded during a strong, sustained northeast wind between Buffalo, New York, and Toledo, Ohio, as a result of this effect. Such a situation can result in severe flooding in low-lying coastal areas in Ohio. Differences in level between the north and south shores, which might effect Pennsylvania, can occur with a strong northwest wind but are generally not nearly as great due to the relatively short fetch of the wind in that direction. With the exception of Presque Isle and several localities near the mouths of creeks, most of the Pennsylvania shoreline is protected from flooding by the 50-100 foot bluffs which line the shore.

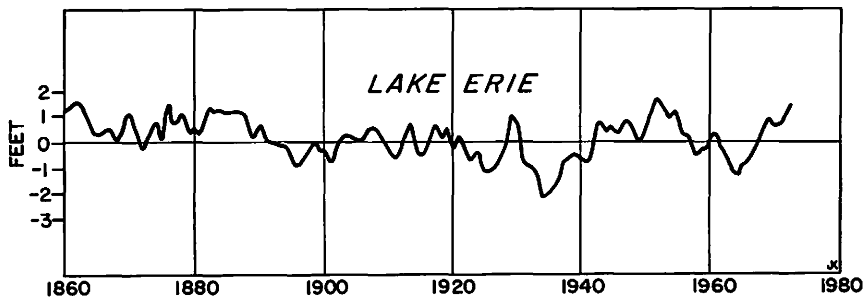


Figure 1. Elevation in feet, referred to LOW WATER DATUM of Lake Erie (period of record 1860-1972) (Courtesy NOAA Lake Survey Center).

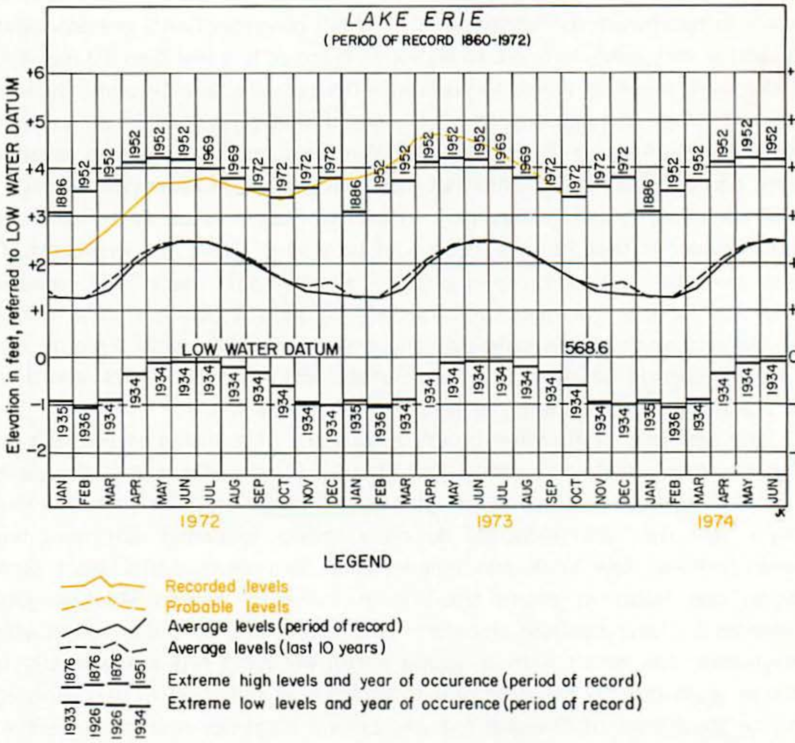


Figure 2. Long term variations in level of Lake Erie since collection of data was begun in 1860. (Courtesy NOAA Lake Survey Center.)

ACKNOWLEDGEMENT: We gratefully acknowledge the help of Mr. John Hanna, NOAA, Lake Survey Center, Detroit, Michigan, for supplying data on the lake levels.

John Barnes

1 Erie Times, Erie, Pennsylvania, March 19, 1973.

BARITE-LIMONITE FROM THE ALTOONA-HOLLIDAYSBURG AREA

During the course of recent mapping in the Altoona region, Blair County, a previously unreported occurrence of barite in limonite has been found. The mineralization occurs approximately one mile north of the Hollidaysburg State Hospital (Fig. 1) in the Tonoloway Formation of Late Silurian age. The occurrence is most easily reached by driving east, southeast, from Route 764 past the sewage disposal plant and parking on the landfill site adjacent to a small quarry. A dirt road, just before the quarry, winds to the northeast behind the quarry and passes near two larger quarries off to the right. The barite-limonite locality is about 50 yards east of the road, north of the second large quarry (see inset on Fig. 1).

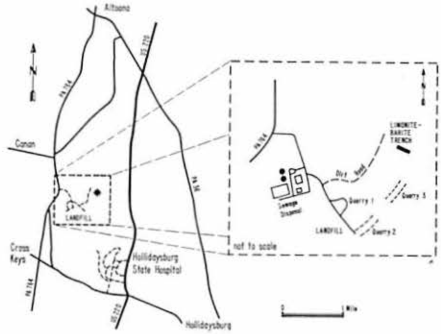


Figure 1. Location of Limonite-Barite.

The barite is white to gray in color, often forming intergrown crystalline masses. Most commonly it is intimately associated with limonite and mammilary goethite. Pure barite is uncommon, but small pieces can be found with crystals 3-5 mm long, 1 mm wide, extending upward from a crystalline base. Crystal growth zoning can be seen in some cleavage faces (Fig. 2). Individual crystals are less common than are masses of crystalline barite in the limonite. Limonite also occurs here without barite. No secondary minerals of lead, zinc, or copper have been observed; chemical analyses show: 170 ppm Zn; 50 ppm As; 20 ppm Pb and less than .1 ppm Ag.

Figure 2. Growth zoning in barite crystals (photos by Les Chubb).

The mineralization is restricted to a relatively narrow, artificial trench in the hillside, approximately 10 feet wide, 30 feet long and 4 feet deep. The elongate shape of the cut suggests that the mineralization occurred along a joint or fault cross-cutting bedding, and the cut probably was made many years ago in search of limonite iron ore.

Several hundred yards south of this cut, the Tonoloway and Keyser limestones are exposed in two rather spectacular, elongate quarries. Stone removal was apparently concentrated along the contact of these two formations, probably in the lower portion of the Keyser Formation.

The Keyser in this area can be recognized by an abundance of fossils: corals, crinoids, brachiopods, algal stromatolites, and ostrocodes. The character of these limestone beds is quite variable and includes argillaceous nodular zones, thin- to thick-bedded fossiliferous and non-fossiliferous units, and even some pure dolomite beds. The lower portion of the Keyser consists of massively crystalline limestone with white and pink calcite veins and "eyes" and is referred to as "calico rock". Solution channels, flowstone and caves are common in the Keyser limestone.

The Tonoloway Formation, typically a thin-bedded to laminated, fine-grained limestone, is much more uniform in character than the Keyser. Thin layers of chert may occur near the top of this unit and fossils are rare. Secondary calcite crystals are abundant, filling vugs and cracks in many of the limestone layers. The type locality of celestite at Bellwood, north of Altoona, occurs in the Tonoloway and casts of salt crystals are plentiful along some bedding planes both at Bellwood and numerous other Tonoloway exposures. Collectors should also be aware of the possibility of finding galena and sphalerite as these minerals have been reported from the Tonoloway Formation north of McConnelstown in Huntington County (Platt, 1881), and from other localities in Pennsylvania (Rose, 1970).

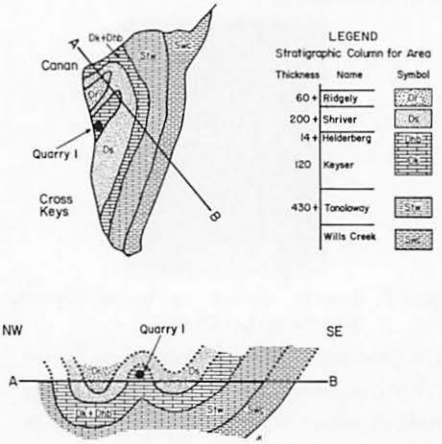


Figure 3. Geology and structure from Butts (1945).

According to Butts (1945) the geology of this area involves simple anticlinal-synclinal fold geometry of Upper Silurian and Lower Devonian formations (Fig. 3). However, recent work suggests that this geometry is complicated by faulting. The limestones in both quarries (#2 & #3) (Fig. 1, in set) dip southeastward and form the west limb of a syncline. In the small quarry (#1) adjacent to the landfill, an anticline is exposed which involves the Keyser and overlying Helderberg Formations, both slightly younger than the underlying Tonoloway Formation. Between this quarry (#1) and the two larger quarries (#2 & #3), a fault has thrust the west limb of the syncline up and over the anticline. This can be seen in Figure 4, a photograph of the small quarry (#1) looking to the north, and in Figure 5 the structural cross-section.

The limonite-barite mineralization, therefore, may be directly associated with this faulting, occurring either in a cross-fault related to this thrust, or a fracture or joint as a direct result of the faulting.

Figure 4. Quarry #1 looking north.

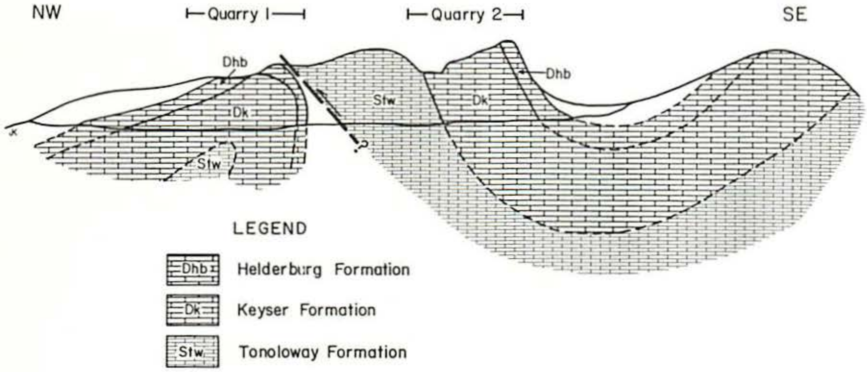


Figure 5. Cross section of quarry #1 and #2.

Butts, Charles, 1945, Description of the Hollidaysburg and Huntington Quadrangles: U. S. Geol. Survey, Folio 227, 20 p.

Platt, Franklin, 1881, The Geology of Blair County: Pa. 2nd. Geol. Survey, Rept. T, 311 p.

Rose, A. W., 1970, Metal mines and occurrences in Pennsylvania, Part 3-Atlas of Pennsylvania's Mineral Resources: Pa. 4th. Geol. Survey, M50, 14 p.

John H. Way, Jr.

GROUND-WATER AND GEOLOGIC STUDIES IN THE WILLIAMSPORT AREA

The Water Resources Division of the U. S. Geological Survey in cooperation with the Pennsylvania Geological Survey is mapping the geology of the unconsolidated deposits and evaluating the ground-water resources of a 450 square mile area that centers around Williamsport, Pennsylvania. The Pennsylvania Geological Survey is mapping the bedrock geology in support of this investigation.

The rapid growth of industry and population in and around Williamsport demands accurate and up-to-date hydrologic and geologic information for the most efficient and economical development of the area's ground-water resources.

The investigation was begun in 1971 and should be completed by 1975. The bedrock geology of the area is being mapped by Roger Faill and Richard Wells of the Pennsylvania Geologic Survey. The ground-water resources are being studied by Orville Bruce Lloyd, Jr. and John Stephenson of the U. S. Geological Survey.

Some expected products of the investigation are listed below:

(1) Maps showing the areal extent, thickness, water-bearing and water-quality characteristics of the bedrock formations and the unconsolidated alluvial deposits in the stream valleys.

(2) Maps showing the general distribution and orientation of fracture traces in the area and discussion of how they relate to the yield of wells.

(3) Maps showing the general distribution of precipitation, evapotranspiration and runoff and discussion of how their relation to one another varies with season and how these variations relate to the amount and kind of ground water available to wells.

(4) Evaluation of the role of induced infiltration from the West Branch of the Susquehanna and its tributaries as a source of water for wells constructed in the alluvial deposits.

The results of the investigation will be published as an interpretative report by the Pennsylvania Geological Survey in their Water Resources Report Series. The report will provide the information needed for the wise development of the area's ground-water resources.

STUDY BASEMENT FLOODING IN KINGSTON AREA

A study is in progress to evaluate the causes and alternative methods of controlling basement flooding in the Kingston-Luzerne area (Luzerne Co.) Penna. The study is being conducted as a cooperative project between the office of Engineering and Construction of the Dept. of Environmental Resources, the U. S. Geological Survey, and the Susquehanna River Basin Commission. Water Resources Report #28, Hydrology of the Pleistocene Sediments in the Wyoming Valley, written by Jerrald R. Hollowell, and published by the Pennsylvania Geological Survey, has provided most of background geologic and hydrologic information for this study.

Rainfall, ground-water levels from 38 observation wells, water levels in selected basements, and stream levels will be monitored for 18 months; and the distribution, composition and hydrologic properties of shallow subsurface sediments (0-30 ft.) will be determined. The record of water level rise and fall in basements will be correlated with rainfall, ground-water and surface-water levels in order to determine the effect of each on basement flooding. Lithofacies maps showing the thickness and distribution of sediments with similar hydrologic properties will be constructed to determine the routing of water from land surface to the water-table, and after it has reached the water-table, to points of discharge. This information will be used to determine the degree of susceptibility of any one area to basement flooding. Seasonal water-table contour maps, as well as water quality data, will be compiled to assist decisions by local authorities concerning future land-use and development.

Several working hypotheses are being tested that might explain basement flooding.

(1) Runoff, after heavy rainfall, percolates into basements on its way to the water table.

(2) Recharge from storm runoff in streams (such as Toby Creek) may raise the water table to elevations above the bottom of basements in the vicinity of the streams.

(3) Ground water may flow through relatively permeable abandoned stream channel deposits and, during times of high water, flood basements which have been excavated on or near these deposits.

(4) Water in abandoned coal mines may flow upward to the shallow water table and, thus, to basements through fractures, adits and boreholes, when the pressure is increased by large amounts of recharge on the hillside adjacent to the valley.

After the cause or causes of basement flooding have been established, measures that might alleviate the problem will be suggested.

CURRENT STATUS OF PENNSYLVANIA'S WATER WELL INVENTORY

Incorporation of the water well data into the computerized data retrieval system has the records of wells drilled in 46 counties on computer printout. This involves almost 1600 pages of printout and 12,500 wells. Information is also available on the remaining counties in the form of drillers' well completion reports which are on file at the Survey's Harrisburg Office. Well records for Adams County, however, were lost in the flood. When new records for this county become available they will be added to the program. The index map in Table I indicates those counties completed to date and the number of wells listed on the printouts for that county.

Assimilation of raw data into the data retrieval system is currently being done on a county basis so that the Geological Survey will at least have some coverage on all counties in the state. When this phase is completed, all counties will be updated and information incorporated into the system as it is received from the driller.

Data Form and Availability

The water well data goes through four steps. Each well is located as accurately as possible on 7½-minute topographic maps. All information is coded onto data sheets which are sent to the key-punch operator. Information for each well requires four key-punch cards. The computer program then produces four series of printout sheets which correspond to the four cards. These are:

1. The *master card* which shows the township, owner, location and well use;
2. The *well description card* which lists the total depth, casing length, screening, drilling method, water level and well yield;
3. the *hydrogeologic card* which identifies the topographic setting, the major and minor aquifers, depth to bedrock, type of bedrock, and the type of surficial material;

4. The *Pennsylvania supplement card* which adds the depths and yields of the water-bearing zones and lists any general chemical analyses.

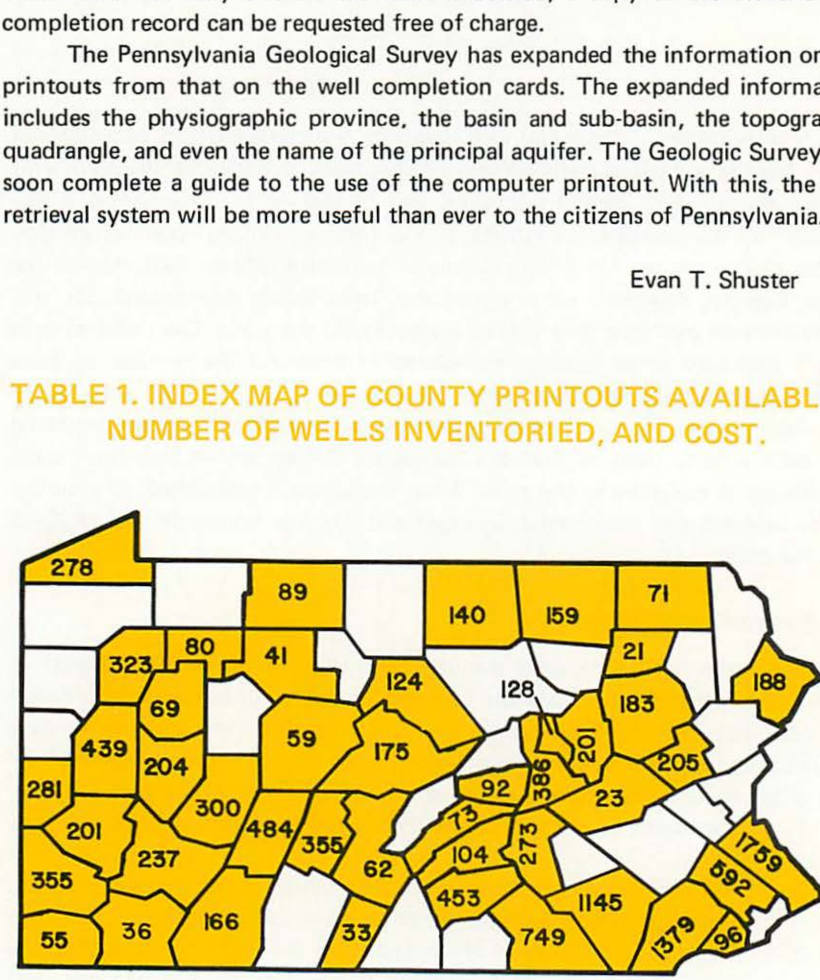
An accuracy code is provided for the well location, depth of the well, altitude of the well at the surface, the water level, and the drawdown when pump tested. The code signifies the relative accuracy of that particular measurement.

Copies of the computer printout sheets are available from the Harrisburg Office at $0.05 per sheet. The wells for each county are grouped by township; the townships are then listed alphabetically. To receive complete information on one well, copies of four printout sheets are necessary. Table 1. lists the number of computer sheets for each county and the total cost. However, when basic information on only one or two wells is desired, a copy of the driller's well completion record can be requested free of charge.

The Pennsylvania Geological Survey has expanded the information on the printouts from that on the well completion cards. The expanded information includes the physiographic province, the basin and sub-basin, the topographic quadrangle, and even the name of the principal aquifer. The Geologic Survey will soon complete a guide to the use of the computer printout. With this, the data retrieval system will be more useful than ever to the citizens of Pennsylvania.

Evan T. Shuster

TABLE 1. INDEX MAP OF COUNTY PRINTOUTS AVAILABLE, NUMBER OF WELLS INVENTORIED, AND COST.



County	No. of Computer Sheets	Total Cost	County	No. of Computer Sheets	Total Cost
Adams	NA		Lackawanna	NA	
Allegheny	28	$1.40	Lancaster	140	$7.00
Armstrong	28	1.40	Lawrence	NA	
Beaver	36	1.80	Lebanon	NA	
Bedford	NA		Lehigh	NA	
Berks	64	3.20	Luzerne	64	3.20
Blair	48	2.40	Lycoming	NA	
Bradford	20	1.00	McKean	12	.60
Bucks	216	10.80	Mercer	NA	
Butler	36	2.80	Mifflin	NA	
Cambria	64	3.20	Monroe	NA	
Cameron	NA		Montgomery	80	4.00
Carbon	28	1.40	Montour	16	.80
Centre	24	1.20	Northampton	NA	
Chester	144	7.20	Northumberland	52	2.60
Clarion	16	.80	Perry	16	.80
Clearfield	12	.60	Philadelphia	No Wells	
Clinton	16	.80	Pike	24	1.20
Columbia	28	1.40	Potter	NA	
Crawford	NA		Schuylkill	4	.20
Cumberland	60	3.00	Snyder	12	.60
Dauphin	36	1.80	Somerset	24	1.20
Delaware	12	1.60	Sullivan	NA	
Elk	8	.40	Susquehanna	12	.60
Erie	40	2.00	Tioga	20	1.00
Fayette	8	.40	Union	NA	
Forest	12	.60	Venango	48	2.40
Franklin	NA		Warren	NA	
Fulton	4	.20	Washington	44	2.20
Greene	8	.40	Wayne	NA	
Huntingdon	8	.40	Westmoreland	32	1.60
Indiana	36	1.80	Wyoming	4	.20
Jefferson	NA		York	100	5.00
Juniata	12	.60			

STATE GEOLOGIST ON NATIONAL COMMITTEES

State Geologist, Arthur A. Socolow, has been designated to serve another three-year term on the American Commission on Stratigraphic Nomenclature, as official representative of the American Association of State Geologists. Dr. Socolow has been Chairman of the Stratigraphic Commission for the past year.

Dr. Socolow has also been appointed as a geologic member of the U. S. National Committee on Tunneling Technology, a committee of the National Academy of Sciences.

SURVEY ANNOUNCEMENTS

NEW REPORT ON PENNSYLVANIA COAL

The Pennsylvania Geological Survey has released a new report entitled, "Analyses and Measured Sections of Pennsylvania Bituminous Coals", by Robert D. Sponseller. This 478-page publication is particularly timely and relevant to the current energy "crisis" for it gives detailed data on the composition, thickness, and geologic occurrence of bituminous coals of western Pennsylvania. The data in this new report will be of direct use to those who plan and actually initiate production of coal in Pennsylvania.

Bulletin M 66, "Analysis and Measured Sections of Pennsylvania Bituminous Coals", is available for $6.30 plus sales tax from the Pennsylvania Bureau of Publications, P. O. Box 1365, Harrisburg, Pa. 17125.

CORE-DRILLING PROJECT IN DuBOIS AREA

As part of our current geologic mapping of the DuBois 15-minute quadrangle, the Pennsylvania Geologic Survey has drilled three long core-holes in the area north and west of DuBois. The cores have been logged in detail and completely photographed as a perminant record. All recoverable coals are to be analyzed. The cores penetrate the interval from the Middle Pennsylvanian Allegheny Group to Mississippian and/or Devonian rocks questionably related to the Pocono and/or Catskill Formations.

The following table is a list of pertinant information for each drill hole:

	Drill Hole #1	Drill Hole #2	Drill Hole #3
Location:	41°10'15"N. Lat. 78°46'10"W. Long. 2½ miles NNW of DuBois on State Game Lands No. 77 Sandy Twp., Clearfield Co. Falls Creek 7½ minute quadrangle.	41°12'57"N. Lat. 78°55'08"W. Long. 1¼ miles NW of Allens Mills in Warsaw Twp., Jefferson Co. Hazen 7½ minute quadrangle.	41°07'41"N. Lat. 78°57'33"W. Long. 1 mile ESE of Emerickville in Pinecreek Twp., Jefferson. Hazen 7½ minute quadrangle.
Surface Elevation:	Approximately 1888 ft.	Approximately 1910 ft.	Approximately 1815 ft.

Stratigraphic Interval:

Above Lower Kittanning Coal to Patton Redbeds	Above Upper Kittanning to Patton Redbeds	Above Lower Freeport Coal to Patton Redbeds

Drilling Depth:

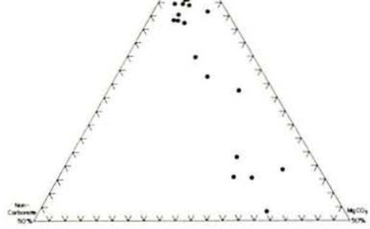
511 ft.	702 ft.	891 ft.

Persons desiring a copy of the drilling records, coal analyses, or other information relating to these drill holes should write or call the State Geologist, Pennsylvania Geological Survey, Dept. of Environmental Resources, Harrisburg, Pa., 17120.

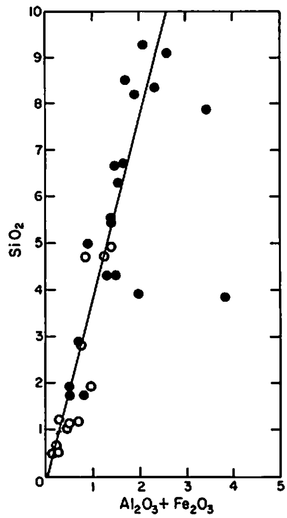
LIMESTONE CHEMISTRY AND ACID INSOLUBLE RESIDUES

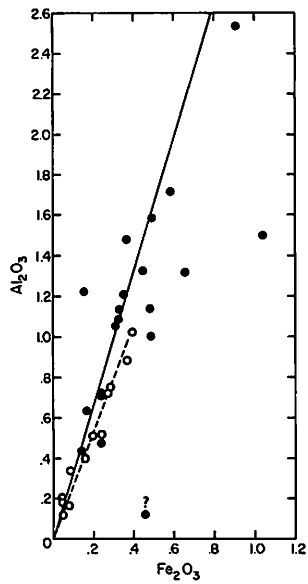
For many years, one aspect of the evaluation of carbonate rocks for their economic utility has involved the study of acid insoluble residues. These residues remain after the carbonate rock has been dissolved in acid. Determination of the amount of acid insoluble residue in carbonate rocks has had its principal use in rapid discrimination between high calcium limestones (> 95% $CaCO_3$) and less pure limestones. From studies in Franklin and Cumberland counties, we now believe that, in addition to measuring the total non-carbonate component of the rock, a study of the acid insoluble residue fraction of the rock will give an approximation of the chemical composition.

To obtain an acid insoluble residue, a limestone sample is crushed to a fine size, weighed, and digested in hydrochloric acid until all the calcium (and magnesium) carbonate has dissolved. That portion that is insoluble in acid remains as a residue which is then decanted, dried, weighed, and calculated as a percentage of the total sample. Chemical analyses of the rock from two quarries studied here indicate that the acid insoluble residue is normally attributable to the analytical constituents SiO_2, Al_2O_3, and Fe_2O_3 (total iron). Usually P_2O_5 and S are reported in the chemical analyses; because they generally constitute less than 0.05% of the sample, they are disregarded for the procedure discussed here. The SiO_2, Al_2O_3, and Fe_2O_3 represent the clay, quartz silt, and very fine quartz sand washed from the iand into a depositional environment analagous to the present-day Bahama carbonate banks. In an area where this terrigenous component is small (15% or less) and is derived from a land mass of somewhat uniform composition, the relative amounts of SiO_2, Al_2O_3, and Fe_2O_3 (total) should be fairly constant.



Twenty analyses from a quarry in the Middle Ordovician limestones of the St. Paul Group in Cumberland County do demonstrate a constant relationship of SiO_2: Al_2O_3: Fe_2O_3 (total). Figure 1 shows the composition of these limestones and indicates that some are dolomitic. A plot of SiO_2 against Al_2O_3+Fe_2O_3 (Figure 2) shows that an approximate linear relationship (visually derived) exists and that from this linearity SiO_2: Al_2O_3+Fe_2O_3 is 3.8:1 a second plot (Figure 3) of Al_2O_3 against Fe_2O_3 also shows a linear relationship from which Al_2O_3: Fe_2O_3 is 3.2:1. This calculation shows





that a typical acid insoluble residue sample from the St. Paul Group at this quarry contains SiO_2: Al_2O_3: Fe_2O_3 in the proportion of 12.2:3.2:1 or approximately 12:3:1. Thus, here acid insoluble residues can be used as a measure of the non-carbonate major oxides, from which it is possible to surmise the utility of limestone for industrial or chemical purpose. For example, a limestone which contains 5% acid insoluble residue can be reckoned by this method, to contain approximately 3.70% SiO_2, 0.98% Al_2O_3, and 0.31% Fe_2O_3.

To confirm the validity of these conclusions 12 chemical analyses of high calcium limestone in the St. Paul Group, from a quarry 50 miles southwest at Marion, Franklin County, were plotted as open circles on the graphs. These points lie approximately on the line (Figure 1) for SiO_2: Al_2O_3+Fe_2O_3 confirming this ratio, as well as substantiating the line at small amounts of acid insoluble material. However, these points do not coincide with the line (Figure 3) for Al_2O_3: Fe_2O_3 but rather another line can be approximated (shown dotted) in which Al_2O_3: Fe_2O_3 is 2.7:1. The moderate difference in Al_2O_3: Fe_2O_3 is virtually negligible in chemical analysis. The ratio, here, of SiO_2:

Al_2O_3: Fe_2O_3 is 10.3: 2.7:1 which for a limestone with 5% acid insoluble residue is reckoned to contain approximately 3.70% SiO_2, 0.96% Al_2O_3 and 0.36% Fe_2O_3 which values are in good agreement with those previously derived. The difference in Al_2O_3: Fe_2O_3 between the two quarries may be accounted for by slight compositional differences in the source terrain.

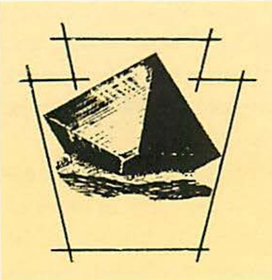
Two factors should be considered which will affect the reliability of these concepts. Secondary silicification, which introduces SiO_2 in the form of chert or quartz rosettes, is a fairly random process in the post-depositional history of the carbonate rocks, and the oxide proportions may vary considerably from those established. Hence, any beds containing chert are suspect and should be sampled with care. Wind-blown quartz grains, although primary in the sense that they accumulated during formations of the limestone, also introduce SiO_2 in a random manner and therefore beds containing visible wind-blown quartz grains are suspect and should be sampled with care. Similarly, laminae of more shaly nature will result in a poor curve or in calculation errors. Weathering will cause the same kind of problems.

As noted previously, the oxide proportions calculated here will vary slightly for various carbonate-rich formations because of differences in land mass composition from which the silt, sand, and clay are derived. This can rapidly be determined by the techniques described here, where abundant reliable chemical analyses are available. The results should be interesting and useful in working out the depositional history of the early Paleozoic in Pennsylvania.

Samuel I. Root
Chief, Field Geology Division

MINERALS ENGINEERS NEEDED

Minerals engineers are sometimes called extractive engineers, or even just mining engineers. Whatever their title, more are needed according to Professor Thomas V. Falkie, chairman of the Department of Mineral Engineering at Pennsylvania State University. He estimates that about twice as many are required by industry as are being graduated from the nation's colleges and universities. For example, students graduating from Penn. State received, on the average, about four job offers each, and a few as many as ten offers. He estimates that about 200 graduates enter the mining engineering field each year, whereas about 400 per year are needed. Furthermore, he believes that in the future this shortage will become worse. This situation in metallics extraction already is grim and the situation in the petroleum and natural gas industry may not be much better. The extraction of metals and mineral fuels such as coal, gas, oil, uranium, iron, silver, copper, and asbestos obviously is a fruitful field for investigation by students. The work not only is interesting but also is important from both economic and environmental standpoints.



EARTH SCIENCE TEACHERS' CORNER

the survey helps high school students

Although our policy always has been to help students with rock, fossil, and mineral identification, during the past year the Survey has given more assistance than usual. No doubt this has happened because the Pennsylvania Geological Survey has become better known and because our new Department of Environmental Resources is having a great impact on our environment, of which geology is an important part.

For the past several years the Survey has been giving a high school student in Harrisburg with field geology, mineralogy, and experimentation concerning Pennsylvania's burning anthracite and culm banks (Pennsylvania Geology, volumes 2/1, 2/5, 2/6, and 3/2). For the second year in a row, Wayne Downey Jr. has won the Grand Championship of the Capitol Area Science Fair with his study of this problem. This year he will travel to San Diego to the national fair and we congratulate him for his earth science studies and for the relevance they have shown to the pollution of our environment.

As a consequence of Wayne Downey's project, the Survey has been able to advise other collectors and students interested in this subject. Among those who contacted us was the Mark T. Sheehan High School in Wallingford, Connecticut. Here, enrichment projects are undertaken as a means of introducing students to the earth sciences as well as to research that requires use of scientific methods. Several projects arising from Mr. Downey's work were suggested and will be incorporated in their program. Among them are the study of crystal growth variations as a result of modification by natural radioactive bombardment, the differences in the conditions for growth of othorhombic and monoclinic sulfur, and the transformation between pairs of hydrous and anhydrous mineral salts, such as gypsum and anhydrite. We not only wish them success in their program of earth science studies, but recommend this approach to high schools in Pennsylvania as excellent scientific training involving relatively simple experimentation.

As a follow-up of Mr. Downey's study, the Pennsylvania Survey will be extending his research. A report on this subject is being prepared by John H. Barnes and Davis M. Lapham with an assist by the U. S. Geological Survey which is performing quantitative chemical analyses of several of the compounds that are believed to represent new minerals. What began as simple assistance by the Pennsylvania Survey has become work of importance both to the science and to the improvement of our life quality. It also has involved many other people and organizations. This is the way of basic scientific research and of scientific service, – a way that we believe is important to each member of our society.

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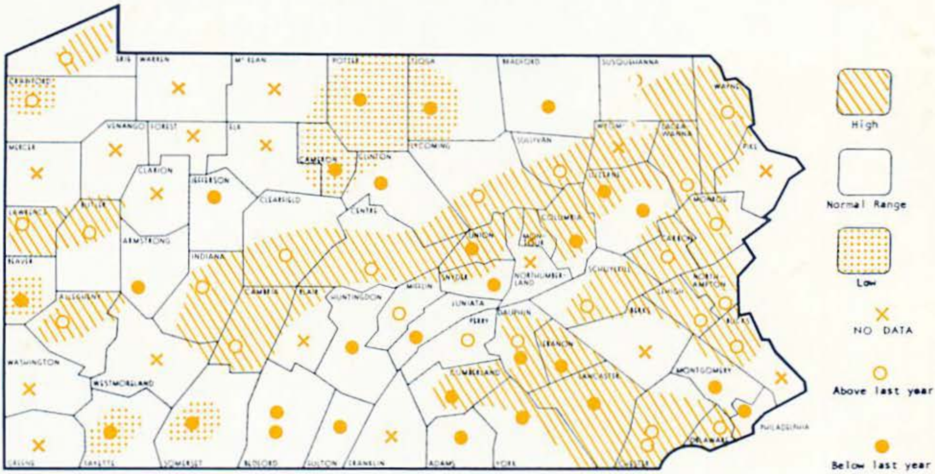
MAY 1973
GROUND-WATER LEVELS



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