PENNSYLVANIA GEOLOGY

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COMMONWEALTH OF PENNSYLVANIA
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TOPOGRAPHIC AND GEOLOGICAL SURVEY
Arthur A. Socolow, State Geologist

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ON THE COVER: A balanced pinnacle about 15 feet high forms part of the crest of Sunset Rocks on Little Rocky Ridge 1 mile west of Pine Grove Furnace State Park, southern Cumberland County. This narrow, rocky spine is the Cambrian (570 million years old) Weverton Formation, a coarse-grained, light-gray, impure sandstone and quartzite. Note the quartz vein near base of pinnacle. Photo courtesy of J. P. Wilshusen.

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JUNE 1981

FROM THE DESK
OF THE
STATE GEOLOGIST

KEEPING UP WITH THE WORLD

I got into a somewhat heated discussion with a colleague recently over a certain new international development, and he asked me why I was so concerned over an affair outside the United States. I tried to explain that in large measure I became an economic geologist because of my fascination with the inter-relationship of minerals to world affairs, both present and past. Historically, one can document the sequence of world trade, colonization, tarrifs, embargoes, and numerous wars, all revolving around the need for, and varying accessibility to, the world's mineral resources. These forces still prevail, and they impact directly into Pennsylvania.

Most conspicuously, the OPEC stranglehold on oil and the mid-East political-military turmoil has stimulated Pennsylvanian oil and gas drilling, as well as expansion of our coal production. Conversely, the ready access to cheap, high grade iron ore in politically friendly foreign nations has lead to the closing of the Grace Mine at Morgantown, Pa., despite large remaining iron ore reserves. The less than happy relations between South Korea and neighboring mainland China has caused Korea to come shopping for coal in Pennsylvania, even while China's coal resources are astronomically high. A renewed national concern over our dependence on foreign sources for various industrially strategic minerals has resulted in inquiries and exploration interest in Pennsylvania for such minerals as chromite, manganese ore, mica, and even substitutes for bauxite, the largely foreign source of aluminum.

Foreign events may also have less direct, but nevertheless significant impacts on Pennsylvania. Governmental turmoil in Latin America, leading to "hot and cold" relationships with the U.S., affect the price and availability of essential copper, nitrates (fertilizer and chemical), tin, iron ore, and quartz crystals, not to mention coffee, bananas, and meat. Strikes, racial upheavals, and border clashes in Africa inevitably impact on Pennsylvania's economy as resources become less (or sometimes more) available.

Even the governmental actions of friendly Canada and the European Common Market affect us as those nations adopt policies of self sufficiency and limitations on foreign (U.S.) investments in their natural resources.

So when you see me reading the foreign affairs column of the *New York Times*, the *Washington Post*, or the *Wall Street Journal*, its not because I've lost interest in Pennsylvania—its because I'm trying to keep up with tomorrow's impact on Pennsylvania.

Arthur A. Socolow

Recovery of ground-water levels from drought conditions in two areas of the Susquehanna River Basin in Pennsylvania

By
James M. Gerhart
John H. Williams
U.S. Geological Survey

Precipitation in the fall of 1980 and early winter of 1981 was significantly below normal in parts of Pennsylvania and other mid-Atlantic states. Ground-water levels were consistently below their normal seasonal ranges and, during the winter, approached the record low water levels set during the drought of the early 1960's. As a result, many municipal and private domestic wells experienced significant reductions in yield and quality; some wells even went dry.

In the late winter and early spring of 1981, precipitation approached normal seasonal amounts. However, above-normal seasonal precipitation still is needed to replenish the ground-water system to its normal levels. Consequently, many ground-water supply systems are still marginal at best, with the possibility of an even relatively short period of below-normal precipitation causing supply problems again.

A prerequisite for improved utilization and managment of ground-water resources is a better understanding and quantification of the ground-water system, including a reliable method of assessing changing ground-water conditions during droughts. A possible method for "tracking" a drought is periodic measurement of ground-water levels in many wells. Two examples of this method were recently completed and the results are presented here.

The U.S. Geological Survey is involved in two ground-water resource evaluation studies in Pennsylvania in which periodic water-level measurements are being made. The Lower Susquehanna River Basin in Pennsylvania and Maryland is being studied in cooperation with the Susquehanna River Basin Commission, and Columbia County and adjacent areas are being studied in cooperation with both the Susquehanna River Basin Commission and the Pennsylvania Topographic and Geologic Survey (see Figure 1 for locations of these

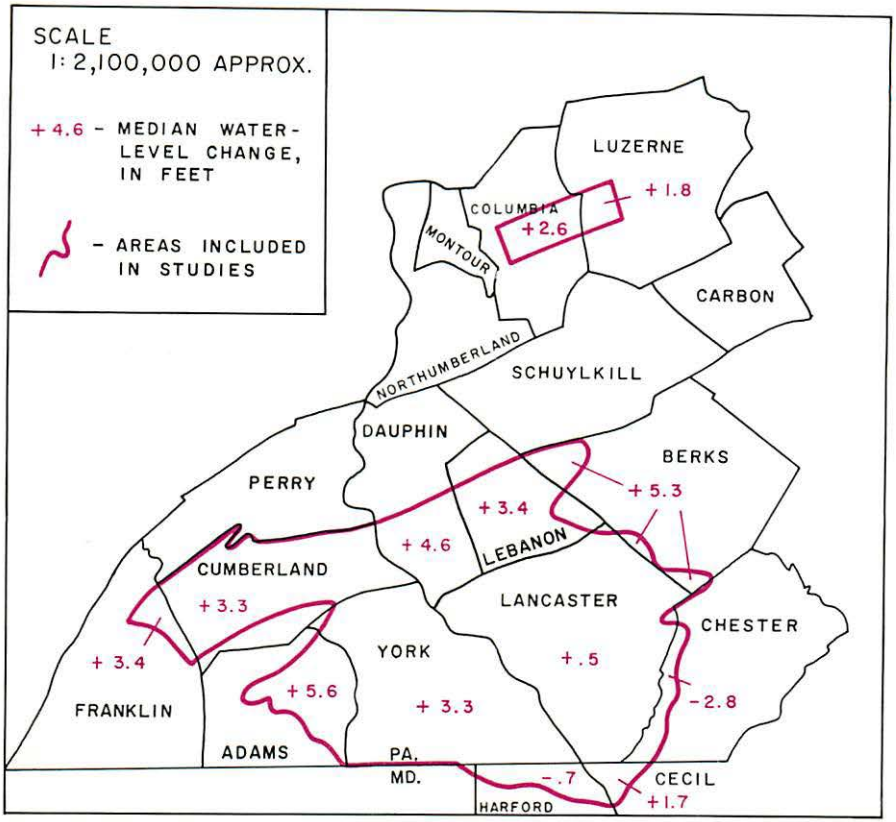

Figure 1. Median water-level changes, in feet, by county, for parts of counties in study areas.

areas). Both studies include the construction of numerical ground-water flow models to be used as tools to evaluate the ground-water resources. As part of the data needed for calibration of these models, seasonal water levels are being measured. So far, water levels have been measured twice in each study area. In the Lower Susquehanna River Basin study, water levels in 331 wells were measured on October 27-31, 1980 and April 20-24, 1981; in the Columbia County study, water levels in 81 wells were measured on December 22-23, 1980 and April 29-30, 1981. Although the initial measurement periods in each study do not coincide, both were during the period of below-normal precipitation and are assumed, for purposes of this discussion, to be representative of drought conditions. The latter measurement periods are representative of ground-water conditions shortly after precipitation had eased the worst drought conditions. The differences between the two water-level measurements in all wells are then estimates of the degree of recovery from drought conditions.

The water-level change data were grouped by county, physiographic province, and gross rock type and topographic setting of wells. Median values were computed for each grouping.

Figure 1 shows the median water-level change in each county during the previously mentioned time period. A positive median change indicates a rise in water level. Median and range of water-level changes for the county grouping are summarized in Table 1. All calculated statistics apply only to those parts of each county or province that are within the two study areas. Water-levels in Lancaster and Chester Counties in Pennsylvania and Harford and Cecil Counties in Maryland show the least recovery. In fact, Chester and Harford Counties show a decline in water levels.

Figure 2 shows the median water-level change in each physiographic province. Table 2 presents a summary of computed statistics for the physiographic province grouping. As with the county grouping, the southeasternmost physiographic provinces show the least recovery, with the Piedmont Upland Section actually showing a slight decline.

Results of both county and physiographic province groupings are probably indicators of regional precipitation patterns. But they do not account for local differences in rock type, topographic setting, and other variables that affect normal seasonal water-level

Table 1. Water-level changes, in feet, by county, in study areas, comparing October 1980 with April 1981*

County	Number of Wells	Median Range	Range of Change	
			High	Low
Adams	20	+5.6	+15.9	+ .9
Berks	6	+5.3	+10.4	+ 4.4
Cecil (Md.)	6	+1.7	+10.9	- 4.9
Chester	7	-2.8	+13.1	-14.6
Columbia*	62	+2.6	+17.6	- 2.4
Cumberland	37	+3.3	+28.1	- 5.2
Dauphin	15	+4.6	+11.8	-10.9
Franklin	6	+3.4	+ 4.9	- 1.7
Harford (Md.)	15	- .7	+10.0	- 4.8
Lancaster	103	+ .5	+23.4	-11.2
Lebanon	32	+3.4	+16.3	-11.7
Luzerne*	19	+1.8	+19.8	- 2.1
York	84	+3.3	+27.1	- 6.8

*Water levels in these counties were measured in December 1980 and April 1981.

change, as well as drought recovery. Therefore, the magnitude of the water-level changes given by the medians are not meaningful values by themselves; but they are apparently useful indices of relative recoveries on a regional scale.

The water-level change data were grouped by gross rock type and topographic setting to analyze variations due to these important factors (Table 3). The shales, interbedded shales and sandstones, and interbedded shales and carbonates show the greatest water-level rise of all the rock types. They also show progressively greater water-level rise from valley bottom to hilltop. Crystalline rocks show the opposite trend. Carbonates show no apparent relationship between topographic setting and water-level change. It is obvious that even at this somewhat more refined level of analysis, there are still some other unanalyzed factors that are important in determining the amount of water-level change in wells. Some other possible factors include thickness of overburden, depth to the water table, depth to water-bearing zones, degree of connection between ground-water and surface-water systems, soil type, land use, and local precipitation differences. Many of these factors are interdependent and their individual effects are difficult to separate from the total effect. To successfully analyze the water-level changes observed over a given time

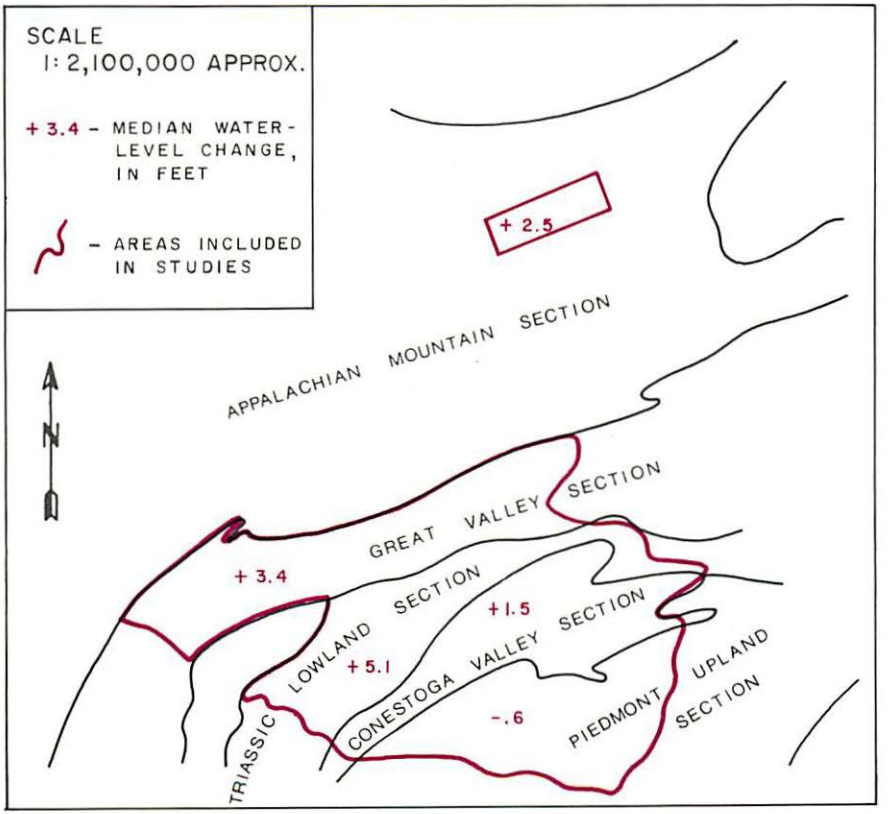

Figure 2. Median water-level changes, in feet, by physiographic province, for parts of provinces in study areas.

Table 2. Water-level changes, in feet, by physiographic province, in study areas comparing October 1980 with April 1981

Physiographic Province	Number of Wells	Median Range	Range of Change High	Range of Change Low
Appalachian Mountain* Section	81	+2.5	+19.8	- 2.4
Great Valley Section	82	+3.4	+28.1	-11.7
Triassic Lowland Section	74	+5.1	+21.9	-10.9
Conestoga Valley Section	92	+1.5	+15.3	-14.6
Piedmont Upland Section	83	- .6	+27.1	- 9.6

*Water levels in this section were measured in December 1980 and April 1981.

Table 3. Median water-level changes, in feet, by gross rock type and topography, for both study areas combined
Number of wells is in parentheses.

Gross Rock Type	Valley Bottom	Lower Slope	Middle Slope	Upper Slope	Hilltop
Glacial outwash	+1.5 (10)	+ .7 (1)	--	--	--
Shale	+2.3 (15)	+2.6 (24)	+3.4 (32)	+3.7 (16)	+ 5.6 (17)
Carbonate	+1.9 (14)	+1.0 (17)	- .2 (32)	+2.0 (23)	+ 1.8 (10)
Interbedded shale and sandstone	+3.4 (4)	+3.2 (22)	+5.7 (27)	+6.4 (20)	+ 7.1 (8)
Interbedded shale and carbonate	+2.6 (6)	+1.6 (3)	+2.8 (1)	+6.3 (2)	+10.7 (2)
Crystalline	+2.7 (1)	+4.8 (15)	+ .7 (38)	-1.1 (35)	- 1.4 (17)

period, one must integrate all these factors and quantify their interactions.

These complications notwithstanding, periodic water-level measurements show some potential for regional assessment of changing ground-water conditions, especially in periods of extreme conditions such as droughts. As shown by this application of periodic water-level measurements, ground-water levels in parts of Pennsylvania and Maryland have not recovered equally well from the drought of the past fall and winter.

PENNSYLVANIA GIVES THE WORLD 3 NEW MINERALS

The recognition of a "new" mineral is a significant event in the mineralogical world. It indicates that here is a substance that has formed spontaneously and is existing in our world, and has never before been found and identified by anyone, anywhere in the world. Of course, the substance isn't really "new," it just hasn't been recognized before. Within the past several years, three substances from Pennsylvania have been recognized and verified by the Commission on New Minerals and Mineral Names of the International Mineralogical Association as "new" minerals. These substances are now known as the minerals desautelsite, downeyite, and matulaite.

Desautelsite ($Mg_6Mn_2^{3+}(CO_3)(OH)_{16}.4H_2O$) was first collected in San Benito County, California, by Thomas D. Palmer. However, the "type specimen" (that which was actually described and named) was collected by Martin Anné and Donald Schmerling of York County at the Cedar Hill quarry in Lancaster County. The mineral was described by Pete J. Dunn, Donald R. Peacor, and Thomas D. Palmer (1979) and was named for Paul E. Desautels, curator of the mineral and gem collections of National Museum of Natural History at the Smithsonian Institution. The mineral is bright orange and forms simple hexagonal crystals, sometimes imbedded in colorless brucite in association with altered serpentine. Desautelsite is chemically related to the mineral pyroaurite, which also occurs at Cedar Hill, but has trivalent manganese (Mn^{3+}) in place of the iron (Fe^{3+}) that is present in pyroaurite (Dunn and others, 1979).

Downeyite (SeO_2) was first collected near vents, from which gases from subsurface fires were escaping, on a burning culm bank near Glen Lyon, Luzerne County. It was described by Robert B. Finkelman and Mary E. Mrose (1977), who named it for its discoverer, Wayne F. Downey, Jr., of Malvern. Downeyite forms as acicular, prismatic, tetragonal crystals that are colorless and have adamantine luster. It forms in association with selenium, sulfur, mascagnite, and $NH_4Al(SO_4)_2$ at temperatures of about 200°C, and is a product of the escaping gases. It is an extremely hygroscopic material. When it is removed from the hot, dry conditions under which it forms, it begins to absorb water, which, in turn, dissolves it. Within a minute or two, the mineral has completely dissolved, with only a drop of clear, colorless liquid remaining (Finkelman and Mrose, 1977).

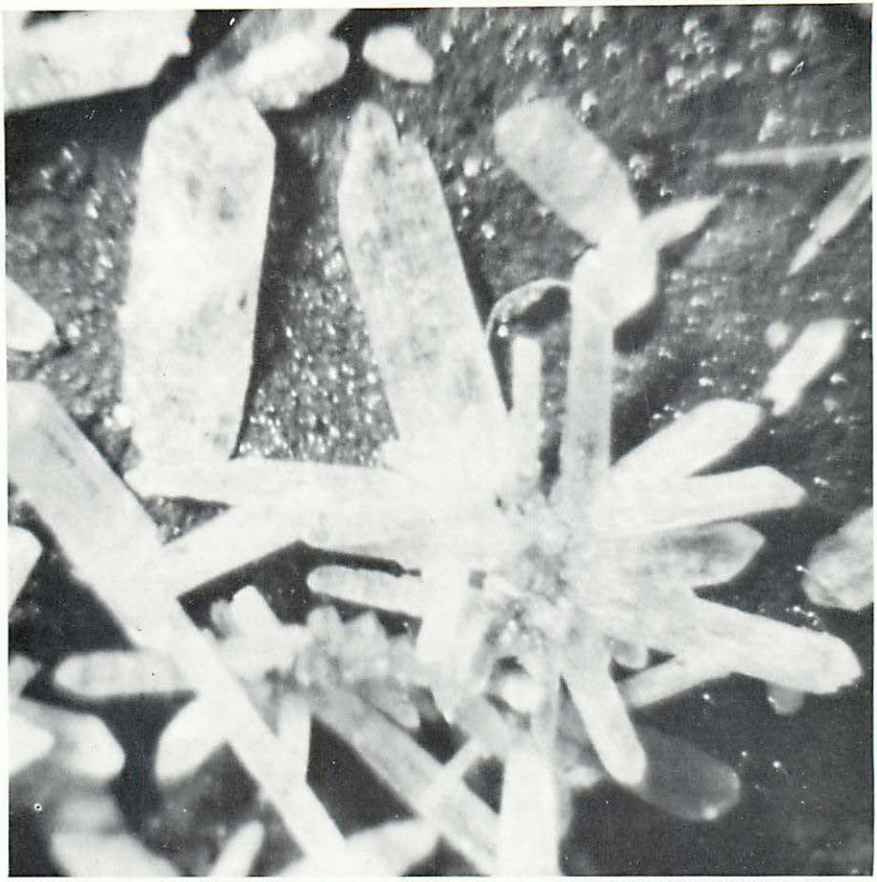

Figure 1: Downeyite (SeO_2) from a burning culm bank near Glen Lyon, Luzerne County.

Matulaite ($Ca(H_2O)_4[Al_9(OH)_{10}(PO_4)_6]_2 \cdot 24H_2O$) is shared by Pennsylvania with North Carolina and West Germany, where specimens were found by Rev. Douglas Berndt and Dr. Roland Dietrich, respectively. The mineral is named, however, for Mrs. Marge Matula, of Allentown, Pa., who provided samples from the Bachman Iron Mine, Hellertown, for the complete study. The mineral was described by Paul Brian Moore and Jun Ito (1980). Matulaite occurs as thin coatings on siliceous rocks associated with goethite and hematite iron ores. It is white with pearly luster and forms as small rosettes of thin, soft scaly crystals, botryoidal aggregates, and thin curved plates (Moore and Ito, 1980).

These recent discoveries are interesting not only in themselves, but in illustrating the potential that still remains for discoveries in a state as long settled, populous, and extensively explored as Pennsylvania. They also illustrate the fine cooperative relationship between amateur and professional mineralogist that this state has

enjoyed. All of these minerals were discovered by amateur mineral collectors. They were studied and named by professional mineralogists at Smithsonian Institution, The University of Michigan, the U.S. Geological Survey, and The University of Chicago.

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EG-7 IS A SURVEY "BEST SELLER"

Heading the list of Survey best sellers for the past year and a half has been Bulletin EG-7, "Outstanding Scenic Geological Features of Pennsylvania" by Alan R. Geyer and William H. Bolles. Since its release in December of 1979, this publication has sold more than 1850 copies. For a geologic publication, this figure is impressive. In 1980 alone, approximately 1600 copies were sold.

The feedback from readers has been quite interesting. Planners are using it to identify outstanding geologic features in their area; a utility company is using it in preparing environmental impact statements for routing new transmission lines; many are planning recreational trips with visits to a particular geologic feature; and, of course, readers have told us they just enjoy reading about this aspect of Pennsylvania's landscape. With almost every letter comes a paragraph or two about an unusual geologic feature omitted or one we must not have known existed which they feel should have been included. In addition, many cited corrections and additions to the text and maps.

"Outstanding Scenic Geological Features of Pennsylvania" is still available from the State Book Store, P.O. Box 1365, Harrisburg, 17125. The cost of this 508-page book is very nominal at $4.50 per copy plus 27 cents sales tax if you are a resident of Pennsylvania. More than 350 of Pennsylvania's outstanding geologic and scenic features are described with a map location to each.

DISTINGUISHED FOREIGN VISITOR

Dr. Yousif Suleiman, Under Secretary of the Ministry of Energy and Mining in Sudan (North Africa) is shown being greeted by DER Secretary Clifford Jones, as Deputy Secretary Peter Duncan and State Geologist Arthur Socolow look on. Dr. Suleiman, a professional geologist and hydrologist, and former Director of the Sudanese Geological Survey, spent three days in April as guest of the Pennsylvania Geological Survey and DER. He was particularly interested in Pennsylvania's technical and administrative procedures pertaining to mining operations and water resources development.

Dr. Suleiman is being sponsored by the Eisenhower Fellowship Foundation of Philadelphia on a three month visit across the United States. His stops include several federal agencies, some prominent research institutes, a few of our major research oriented industries, and several universities. The Pennsylvania Geological Survey was selected by the Eisenhower Foundation as an appropriate state organization with program and research activities of direct relevance to Dr. Suleiman and his nation. We were pleased to be able to exchange information with our distinguished visitor.

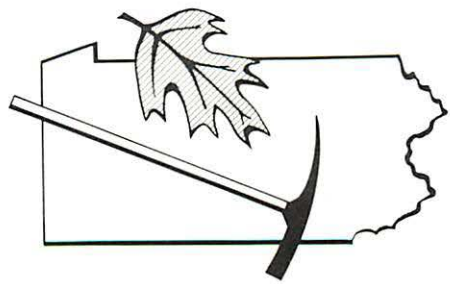
1981 Field Conference of Pennsylvania Geologists

The Annual Field Conference of Pennsylvania Geologists will be held in the north-central part of the state this year—a first in the 46-year history of the annual conference. The October 1, 2, and 3 meeting will focus on the general geology of Tioga and Bradford Counties, and will cover aspects of the bedrock stratigraphy and structure, glacial history, geomorphology, paleontology, coal geology, and engineering geology. Wellsboro will be the conference headquarters this year. Field trip stops will include outcrops near Burlington, Towanda, Franklindale, and LeRoy in Bradford County, and Tioga, Liberty, Morris, and Antrim in Tioga County. Of course, one of the field trip stops will be at Pennsylvania's Grand Canyon in Tioga County. Two of the stops will be at the new Tioga-Hammond Lakes Project.

The 1981 Field Conference is being organized by T. M. Berg of the Pennsylvania Geologic Survey. Other trip leaders include: D. M. Hoskins, W. D. Sevon, and J. P. Wilshusen (Pa. Geologic Survey); G. H. Crowl (Ohio Wesleyan Univ.); W. E. Edmunds (Consultant, Camp Hill); W. Franklin (U.S. Corps of Engineers); P. B. Luce (Mansfield State College); H. Pohn (U.S. Geological Survey); and D. L. Woodrow (Hobart & William Smith Colleges).

Tioga and Bradford Counties will provide an exciting array of geological wonders for Conference participants, but will also provide a visual feast because of the magnificent fall colors for which the counties are famous.

The conference is intended for professional geologists and graduate geology students. If your name is not already on the Field Conference mailing list, you may have it entered by sending your request to: Field Conference of Pennsylvania Geologists, c/o Pa. Geologic Survey, Box 2357, Harrisburg, PA 17120.



SURVEY ANNOUNCEMENTS

SAM W. BERKHEISER, JR., JOINS SURVEY

Sam W. Berkheiser, Jr., joined the Bureau of Topographic and Geologic Survey in April 1981 as an economic geologist with the Mineral Resources Division in Harrisburg.

Mr. Berkheiser received an A.B. in Geology from Catawba College in 1971 and an M.S. in Geology from Eastern Kentucky University in 1974. He previously has been employed by the Atlantic Richfield Company's Synthetic Crude and Minerals Division, and most recently with Dunn Geoscience Corporation. His experience includes projects involving aggregates, cement, clays, barite, basic refractories and various other industrial minerals.

Sam's responsibilities will include field investigations and resource studies of the State's industrial minerals. This will help to provide a better inventory of these important minerals and will serve the needs of planners, property owners, and the mineral development industry.

MARTHA WALTER RETIRES

Mrs. Martha Walter, data analyst with the Environmental Geology Division, retired on June 24th after completing almost 14 years of continuous, dedicated State service—the last 4 years with the Bureau of Topographic and Geologic Survey.

Martha, a native of Warren, Pennsylvania, started with the Commonwealth in the Department of Health, Bureau of Vital Statistics as a clerk. From this position she advanced in the Health Department to an Administrative Officer in the "old" Bureau of Sanitary Engineering. When this bureau became part of the Department of Environmental Resources, she was assigned to the DER's Bureau of Water Quality Management in January 1971.

Since 1977, Martha has brought to the Survey's water well inventory program, an efficient and highly professional performance and service to all.

Martha plans to spend more time with her children and enjoy her new home in the Pocono's. We wish her the best in her future activities.

Distribution of Geologists in Pennsylvania 1974 - 1980

by Pauline F. Silsley and Reginald P. Briggs
Geomega, Inc., Pittsburgh

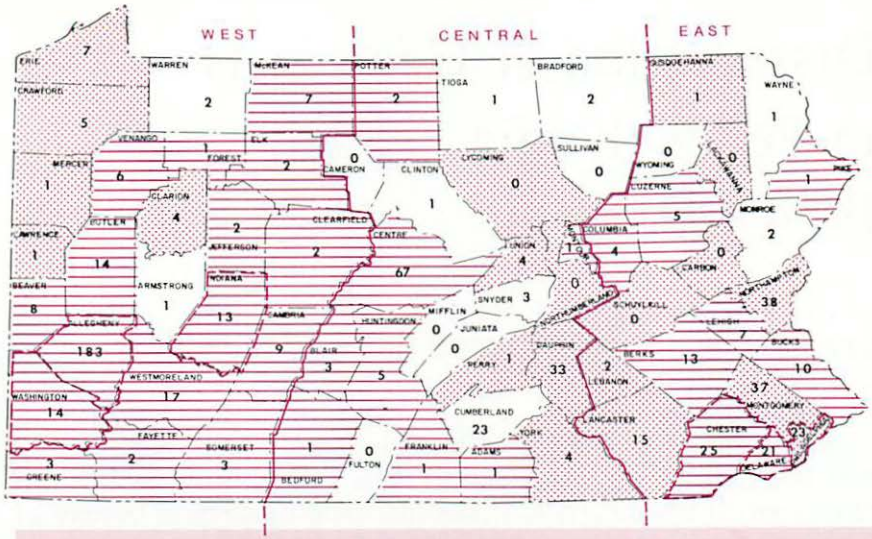
In the June 1975 issue of "Pennsylvania Geology" we reported that 586 geologists in Pennsylvania were listed in the 1974 annual directories of one or more of the following: Geological Society of America, American Association of Petroleum Geologists, American Institute of Professional Geologists, and Association of Engineering Geologists. It was noted that this number certainly did not include all geologists in Pennsylvania, an extrapolation of the fact that almost half of the 200-plus members of the Pittsburgh Geological Society belonged to none of the cited four National societies.

Now, six years later, we have examined the 1980 directories of the same National societies and find significant change. Last year there were 665 listed geologists, a 13.5 percent increase in a state with declining population. In 1974 there was one listed geologist for every 20,000 residents (1970 census figures); in 1980 one for every 17,700 residents (1980 census figures).

Moreover, this change is not just the result of building on a more or less stable core of "veteran" Pennsylvania geologists. Rather, the 1974 to 1980 comparison shows clearly what we have seen told all along; ours is a pretty mobile profession. Of the original 586, fewer than half remain listed in Pennsylvania.

Of the about 300 gone, 128 are now listed elsewhere. Texas claimed 29, Colorado 11, California 10, four other states at least 5 each, 48 are scattered through twenty-nine more states, and 8 went foreign. At least 5 geologists we know have died in the interim and another 15 or so we know have dropped out of society membership for a variety of reasons. But that leaves about 150 unaccounted for; they too are no longer listed in any of the four directories. They certainly have not all retired, died, or gone into other lines of work.

As a speculation, a factor may be the recent costs of membership compared to what is perceived as the value of membership. Many may have simply resigned or less formally dropped their memberships, and they may still be geologizing in Pennsylvania. In any case, the missing 150 are a puzzle that deserves attention.



Map showing numbers of geologists listed in 1980 and counties that gained or lost geologists 1974 to 1980. Horizontal lines—gain. Stippled—loss. No pattern—unchanged. Solid heavy lines separate informal zones. Counties with most significant gains or losses outlined by heavy dashed lines (see table 1).

Table 1. Pennsylvania Counties With Ten or More Geologists Listed In 1980, Compared to 1974

1980	1974	County	Number of Geologists 1980	Number of Geologists 1974	Growth (Decline) 1974 to 1980 numbers	Growth (Decline) 1974 to 1980 percent	Number of Geologists per 17,700 population [1] 1980
1	1	Allegheny	183	136	47	34.5	2.2
2	2	Centre	67	57	10	17.5	10.7
3	3	Northampton	38	45	(7)	(15.5)	3.0
4	5	Montgomery	37	39	(2)	(5.2)	1.0
5	5	Dauphin	33	39	(6)	(15.4)	2.6
6	10	Chester	25	11	14	127.3	1.5
7 tie	7	Cumberland	23	23	0	0	2.3
7 tie	4	Philadelphia	23	42	(19)	(45.2)	0.2
9	10	Delaware	21	11	10	90.9	0.7
10	9	Westmoreland	17	12	5	41.7	0.8
11	8	Lancaster	15	21	(6)	(28.5)	0.8
12 tie	14	Butler	14	9	5	55.5	1.7
12 tie	21	Washington	14	5	9	180.0	1.2
14 tie	15	Berks	13	8	5	62.5	0.7
14 tie	21	Indiana	13	5	8	160.0	2.7
16	17	Bucks	10	6	4	66.7	0.4

[1] Statewide mean is 1 geologist per 17,700 population (1980 census).

Making up for those gone elsewhere or otherwise lost are an even larger number of new names, but time forbade attempting to trace them backwards. We guess a sizeable proportion are young geologists who had not their degrees or who had not yet joined in 1974. Clearly another large contingent results from the energy boom now under way in western Pennsylvania; more experienced geologists have been transferred here by their companies.

In the 1975 article, a map showed distribution of geologists by county, and a table showed the 11 counties (11 as there was a tie for 10th place) with greatest numbers of listed geologists in 1974. The enclosed Table 1 shows that the top 11 counties are the same as 6 years ago, but there are significant changes in numbers and order. In Philadelphia, for example, listed geologists declined by close to half, and rank changed from 4th to a tie for 7th. Chester County now is 6th. Allegheny County is a reinforced number 1 with almost thrice the numbers of 2d-place Centre County, but Centre County (Penn State) remains by far the leader in geologists per total county population, with just over 10 times the state average.

As the table shows, the chief geological centers of 1974 remain those of 1980. However, the enclosed map illustrates a trend in growth of geological populations. Eastern, central and western zones of respectively 20, 24, and 23 counties are separated by heavy lines (without official significance). In the eastern and central zones, counties show a mixture of gains (notably Chester and Delaware), losses (most notably Philadelphia), and stability of geological populations. In each of these two zones, though, the summary 1974 to 1980 change is zero. In contrast, in the western zone, only 7 counties had losses or were stable and 16 show more geologists. In addition to Allegheny County's almost startling gain of 47, Butler, Indiana, Washington, and Westmoreland Counties each added 5 or more. The western zone accounted for *all* the gain in total listed Pennsylvania geologists from 1974 to 1980. During that period many young geologists took Greely's advice and went west to where the jobs are.

A RARE ASTRONOMICAL DISPLAY

The climax of this year's Great Conjunction, which is actually a triple conjunction of Jupiter and Saturn, will take place on the evenings of August 31 and September 1 when the three brightest planets, Venus, Jupiter, and Saturn; the first magnitude star, Spica;

and the crescent moon will appear together in the western sky soon after sunset.

The first of the three conjunctions took place on December 31, 1980; the second on March 4, 1981; and the third will take place on July 24, 1981. These planets move so slowly among the stars that an event of this type is very rare, not occurring again for 257 years. A discussion of these dates and their significance can be found on pages 224 and 225 of the March, 1981 issue of *Sky and Telescope*.

These two planets are extremely close visually during the first eight months of 1981 and periodically form attractive groupings with the moon. Prior to the month of March they could be best seen in the morning before sunrise; after March they are best observed in the night sky after sunset.

On April 16th, the moon, approaching full, will be close to Jupiter and Saturn and will be to the east of them on the night of April 17.

In May, the best nights for close grouping of the moon and the planets will be May 13, when the moon, just past quarter phase, will be west of the planets, and May 14, when it will be east of them.

The dates of June 9, 10, and 11 will again have the moon close to the planets at the first quarter phase. The closest groupings will be June 10.

In July, the moon and the planets will again appear close on the nights of the sixth and seventh, and again on the third of August.

All of the preceding, though impressive, are preliminary to the wonderful display beginning about August 24, when Jupiter and Saturn are joined by Venus. This grouping, appearing low in the west-southwest in the evening twilight, continues to the end of August. On August 31 and September 1, the three planets with the crescent moon and the first magnitude star, Spica, will be lined up. Be sure to remember to watch the western sky on the nights of August 31 and September 1.

In addition to the *Sky and Telescope* reference made earlier, additional information can be found in an article on the Great Conjunction in the February, 1981 issue of *Astronomy* and a special report on the Great Conjunction prepared by the staff of the Abrams planetarium of Michigan State University.

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Science Education Adviser
PA Department of Education

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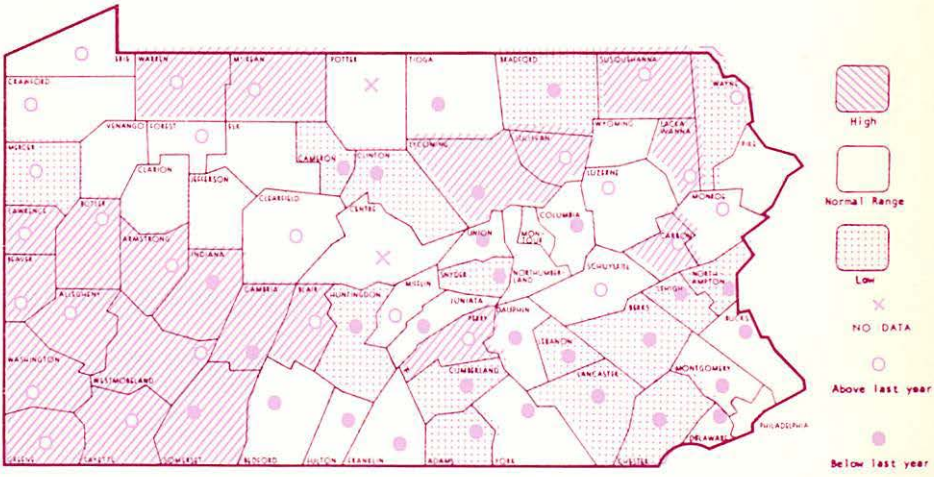

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