GEOLOGY PENNSYLVANIA

THE PENNSYLVANIA GEOLOGICAL SURVEY VOL. 10/3

COMMONWEALTH OF PENNSYLVANIA
Richard L. Thornburgh, Governor

DEPARTMENT OF ENVIRONMENTAL RESOURCES
Clifford L. Jones, Secretary

TOPOGRAPHIC AND GEOLOGICAL SURVEY
Arthur A. Socolow, State Geologist

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ON THE COVER: Normal faults exposed in limestone quarry of York Stone and Supply Company at York, Pennsylvania. For scale, note figure on "bench" in center of photo. Photo courtesy of Pennsylvania Historical and Museum Commisson.

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

JUNE 1979

FROM THE DESK
OF THE
STATE GEOLOGIST . . .

A NEW CHALLENGE

As reported in this issue, the Bureau of Topographic and Geologic Survey has taken on a regulatory function, now that the Division of Oil and Gas Regulations has been transferred to our Bureau. We already have a pleasant and constructive working relationship with the oil and gas exploration industry, by virtue of the data and services provided by our long established Division of Oil and Gas Geology. It is our hope and intention to develop a constructive working relationship with the oil and gas drilling industry as we take on the legislatively mandated functions of assuring physically and environmentally proper oil and gas drilling and plugging practices. Of course, it won't always be easy; we recognize that a complex industry will have complex problems. And we recognize that there is a responsibility to protect the interests of all Pennsylvanians. We are also very much aware that as a major energy consuming state, we can use all the new oil and gas that can possibly be developed within our borders.

The Bureau of Topographic and Geologic Survey accepts the new challenge, with all of its ramifications. It is our hope that if all parties involved are reasonable, the results will also be fair and reasonable. After many decades of geological services to the Commonwealth, our Survey has a well established, professional reputation. We are well accepted as the "guys with the white hats," and even with our new range of responsibilities, we do not plan to change our hats.

Arthur A. Socolow

LANDSLIDE ENCOUNTERS

by John P. Wilshusen

Landslides occur in Pennsylvania and are widespread in the spring when the ground thaws, saturating soil and rock. At that time rocks fall from road cuts and soil slumps on hillsides. Debris slides of rock, soil and vegetation are also common, especially during periods of heavy rainfall. All three types of landslides may involve homes, industry, roads and farmlands. Each rockfall, slump and debris slide, (Figures 1-3) is representative of commonly observed landslides in Pennsylvania. In addition to these, however, large complex slope failures (Figure 4) occur in western Pennsylvania. These occurrences involve slump, debris slide, flow, rotation and lateral translation of the moving material from the beginning to the end of the movement.

Rockfall is the free fall from a rock face, or bounding down a steep slope, of rock fragments loosened by frost and ice wedging, flowing water, or tree root wedging. It occurs wherever there is a steep rock face present, both man-made and natural.

Figure 1. Rockfall from a road cut in central Pennsylvania.

Figure 2. Soil slump from a hillside in a farm field.

Figure 3. Debris slide on a forested mountain slope.

Figure 4. Upper portion of a large complex slope failure in western Pennsylvania.

Slump frequently takes place in soil and weathered rock above the bedrock surface. It is caused by excessive water in the soil and results in slope failure. A depression opens at the head of the slump and a mound of hummocky soil forms at the toe. Slump is associated with very wet, particulate soil and weathered rock and may occur on a gentle slope as well as a steeper one. Undercutting at the base of the slope, either natural (a stream) or man-made (a road cut), accelerates slumping.

Debris sliding is the downslope movement of soil, rock and trees along a planar surface. It is associated with steep, unstable slopes and is often expressed as a stripped out pathway down a mountainside. Movement starts near the top with the mass of sliding material knocking out everything in its path until it comes to rest as a jumbled, chaotic heap.

The complex slope failures that occur in western Pennsylvania are directly related to rock structure, composition, and topography. The dip of the bedrock layers is almost flat, with successive stratigraphic units composed of sandstone, siltstone, shale, coal, clay and limestone. Collectively, these rocks form a broad plateau characterized by narrow, steep-sided valleys and broad, flat ridge crests. Most of the bedrock units are broken by joints and bedding plane openings

Oil And Gas Regulatory Division To Pennsylvania Survey

The Division of Oil and Gas Regulation, formerly with the Bureau of Land Protection, has been transferred to the Bureau of Topographic and Geologic Survey. This is one of a number of recent reorganizational moves within the Department of Environmental Resources, designed to bring together related functions for more effective service.

The Division of Oil and Gas Regulation is based in the Kossman Building, 100 Forbes Avenue, Pittsburgh 15222, as is the Division of Oil and Gas Geology, a long-standing member of the Bureau of Topographic and Geologic Survey. These two Divisions will continue their separate identities and functions, but will maintain close coordination.

The Division permits, regulates and inspects wells drilled for oil and natural gas, wells used for underground storage of natural gas and wells to be plugged and abandoned. This Division will also be responsible for implementing the State's responsibilities to the new Natural Gas Pricing Act recently passed by Congress.

In taking on the Division of Oil and Gas Regulation, the Survey enters into a major new role of regulation and inspection. Our intent is to address this responsibility with the same professional standards and integrities that have stood us well over the years.

Landslides continued

which allow ground water to move freely through the rock mass. There are, however, some relatively impervious clay units which interrupt ground water circulation resulting in a build up of pore water pressure. This creates an instability which may lead to slope failure.

The complex landslides come in all sizes, ranging from small movements in a yard or along a highway to massive failures involving entire hillsides and communities. Though western Pennsylvania is noted for this type of landslide, it does not appear to have the largest in the state; that honor may belong instead to a prehistoric landslide in which a massive slice of mountain separated from the main mountain northwest of Nanticoke in Luzerne County.

In addition to the types of landslides discussed here, there are others: debris avalanche, rockslide, earthflow and mudflow. Those described above, however, are the most frequently encountered in Pennsylvania.

History Of Streamflow Records For The Susquehanna River At Harrisburg, Pa.

by Carney P. Humphreys
Water Resources Division
U.S. Geological Survey

The rich history of the Harrisburg area has from its very beginning been closely associated with the Susquehanna River which flows by the city's doorstep. Data from the river have been used for many purposes, but, by far, the most important use has been in the development and management of this valuable natural resource.

The first official record of river levels began in 1874. Mr. William Kelker read gage heights from a vertical, painted, staff gage on a pier of the old Market Street bridge from 1874 to 1893.

The systematic collection of daily observations of river gage heights began with the establishment of a staff gage in the pump well of the old Harrisburg Water Works at the foot of North Street in October 1890. Mr. E. Mather, President of the Harrisburg Water Board, made readings at this site from October 1, 1890 to July 18, 1904. An interesting note here is that the "zero" or lower end of the gage was set at the "low water mark" of 1803 or 289.4 feet above mean sea level. This later enabled hydraulic engineers of the U.S. Geological Survey to utilize this gage-height record to compute daily river discharge for the period. The first measurement of streamflow discharge was made March 31, 1897 by Mr. Paul of the Water Supply Commission of Pennsylvania.

On July 18, 1904, the U.S. Geological Survey installed a standard "chain type" river gage on the upstream side of the present Walnut Street Bridge which is 2100 feet downstream from the old Water Works Pumping Station at North Street. Records were kept at this site until September 30, 1928.

In 1928, a reinforced concrete gage house and well were constructed on the east bank of the river at Nagle and Front Streets in Shipoke to house an automatic, continuous, gage-height recorder. This gaging station was financed by the Philadelphia Electric Power Company and operated by the U.S. Geological Survey under a Federal Power Commission license. Official streamflow records were collected at the Nagle Street gage until August 31, 1975.

The record-breaking flood of June 1972, caused by Tropical Storm Agnes, produced a flood level 0.2 feet above the roof of the

Susquehanna River monitoring and gaging station at Harrisburg: Historic flood marks are marked along right edge of scale on building; flood stages recorded for 1975, 1972, 1936, 1894, 1889, and 1784.

Instruments in Susquehanna River monitoring station at Harrisburg; includes automated LANDSAT satellite data collection system, electrical tapes, and recorders.

Nagle Street gage. Because of the need to measure floods and to have flood-warning devices in continuous operation, the gage had to be relocated. The new gage was established on City Island near the eastern edge of the island and 60 feet downstream from the Market Street Bridge. This station is operated by the U.S. Geological Survey under cooperative programs with the Pennsylvania Department of Environmental Resources, the National Weather Service and the Philadelphia Electric Company. Records began at this gage on September 1, 1975 and continue to date.

The latest type of instrument to be operated in the City Island gage is a Convertible Data Collection Platform which transmits river stages once every three hours to a Geostationary Operational Environmental Satellite (GOES) some 22,300 miles above the equator. The GOES immediately relays the data back to an earth receive site at Wallops Island, Virginia where it is relayed via dedicated landlines to various data users including the U.S. Geological Survey, National Weather Service River Forecast Center, and the U.S. Army Corps of Engineers. About 8 seconds time is required for the data to make its round trip journey to the satellite.

The National Weather Service has utilized the several gages in the Harrisburg area to monitor river levels and to forecast floods; but, their periods of observed record at each of the gages differ from those of the U.S. Geological Survey.

Water-quality records are also available for the Susquehanna River at Harrisburg. The U.S. Geological Survey has published partial records of water quality from October 1944 to January 1953 and from March 1956 to present. Daily records of specific conductance, pH, water temperature, and dissolved oxygen have been collected and published since May 1974. Daily suspended sediment discharge records are available from October 1963 to September 1968 and from April 1970 to the present.

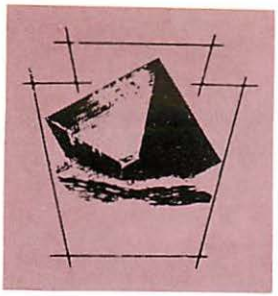
In addition to the station at Harrisburg, the Pennsylvania District of the U.S. Geological Survey maintains 265 continuous streamflow gaging stations, 195 partial-record gaging stations (crest-stage and low-flow), 55 chemical and sediment stations, and 67 observation wells. Hydrologic data for these sites are published annually in "Water Resources Data for Pennsylvania." The publication is in three volumes:

Volume 1. Delaware River Basin

Volume 2. Susquehanna and Potomac River Basins

Volume 3. Ohio River and St. Lawrence River Basins

For information on water resources data in Pennsylvania contact the U.S. Geological Survey, Water Resources Division, P.O. Box 1107, Harrisburg, Pennsylvania 17108.



EARTH SCIENCE TEACHERS' CORNER

EARTH AND SPACE SCIENCE IN PENNSYLVANIA: A TWENTY YEAR PERSPECTIVE

by William H. Bolles, Science Education Adviser,
Department of Education

The revival of the Earth Sciences in Pennsylvania began early in 1958 when the then Department of Public Instruction prepared the first outline for a course to be called Earth and Space Science. The work began under the direction of Dr. Charles Boehm, Superintendent of Public Instruction, and grew out of his attendance at an Air Force Convention held in Dallas, Texas. In his words, "This experience led to the realization that the Space Age in which we now live, and about which we know so little, will be commonplace to our students. Therefore, the inclusion of Earth and Space Science in the program of Pennsylvania's public schools has become an imperative issue."

In 1959 the first Earth and Space Science Teaching Guide was published and in 1961 a comparable guide was developed for elementary school teachers. The secondary guide was revised in 1963 and an entirely new guide published in 1973.

The introduction of the earth sciences in Pennsylvania coincided with the decision of the American Geological Institute to develop up to date resource materials for secondary school teachers. In the summer of 1959 a conference was held at the University of Minnesota, known as the Duluth Conference, which resulted in the publication of a Geology and Earth Science Sourcebook by Holt, Reinhart and Winston in 1962.

The National Science Foundation awarded a grant in 1963 which continued these efforts to improve earth science education and the project became the Earth Science Curriculum Project (ESCP) with headquarters at Boulder, Colorado. Dr. Robert Heller was the first director. The resulting course, Investigating The Earth, was pilot tested at two centers in Pennsylvania. The Harrisburg center was directed by Alan Geyer of the Pennsylvania Geologic Survey while

EARTH AND SPACE SCIENCE ENROLLMENT DATA

Years	Total Enrollment	% Change	ESCP Enrollment	ESCP %	Total Secondary Enrollment	% Change	% Earth Science of Total Enrollment
1958-59	* 4,500				736,269		0.6
1959-60	* 25,000	+ 455.6			797,711	+ 8.3	3.1
1960-61	36,696	+ 46.8			818,246	+ 2.6	4.5
1961-62	68,431	+ 86.5			853,311	+ 4.3	8.
1962-63	65,280	- 4.6			899,518	+ 5.4	7.3
1963-64	73,288	+ 12,3			944,491	+ 5.0	10.2
1964-65	114,780	+ 56.6			966,808	+ 2.4	11.9
1965-66	132,149	+ 15.1			970,358	+ 0.4	13.6
1966-67	102,855	- 22.2			988,248	+ 1.8	10.4
1967-78	108,247	+ 5.2	8,074	8	1,019,787	+ 3.2	10.6
1968-69	112,439	+ 3.9	36,638	33	1,049,724	+ 3.1	10.7
1969-70	118,754	+ 5.6	45,891	39	1,078,943	+ 1.5	11.0
1970-71	131,005	+ 10.3	45,538	35	1,099,570	+ 1.8	11.9
**1971-72	137,074	+ 4.6	48,195	35	1,121,826	+ 2.7	12.2
1973-74	139,074	+ 1.5	50,472	36	1,137,660	+ 1.8	12.2
1975-76	124,718	- 10.3	40,550	33	1,116,696	- 0.7	11.2
1977-78	122,385	- 1.9	34,178	28	1,074,833	- 4.1	11.4

*Estimated enrollments.

**Data collected every other year from this date.

All data from Secondary Public School Report unless otherwise indicated.

the Lancaster center was under the direction of Jacob Freedman of Franklin and Marshall College.

Each center involved five schools during the 1964-65 school year. The materials were revised and tested again during the 1965-66 school year but the Harrisburg center was dropped in an effort to reduce costs.

The Investigating The Earth text was available for the 1967-68 school year, however, its late appearance resulted in its being adopted by only a relatively small number of schools. The ESCP enrollment that year was only 8% of the total number of students taking Earth and Space Science. The next school year the percentage rose to 33% and the following year to a high of 39%. In actual numbers of students enrolled in Investigating The Earth, the 1973-74 school year was the highest with 50,472 reported. Increasing enrollment brought the percentage this year to only 36%.

Although total enrollments are decreasing, the number of students in the Earth and Space Science curricula has been relatively stable since 1963-64.

The philosophy continues in Pennsylvania that this is a course for all students. At a time of increasing awareness of environmental concerns and a greater awareness of energy problems and needs there can be no better background upon which to build understanding of these issues than a study of the earth sciences. This interdisciplinary approach to the study of geology, astronomy, meteorology and oceanography is as much needed now as it was in the early days of the Space Age.

SURVEY ANNOUNCEMENTS

AVAILABLE MAPS AND CROSS SECTIONS OF DEVONIAN ORGANIC-RICH SHALES AND SANDSTONES OF WESTERN PENNSYLVANIA

The Bureau of Topographic and Geologic Survey, in cooperation with the Morgantown Energy Technology Center of the U.S. Department of Energy (under contract EY-76-S-05-5198), is in the process of completing a three-year study of the Middle and Upper Devonian organic-rich black shales in the subsurface of Pennsylvania. This study has involved regional and detailed geologic investigations of the organic-rich shales and their relationship to the total Middle and Upper Devonian clastic sequence in the northern and western part of the state. As a result of this study, nine stratigraphic cross sections and two maps at a scale of 1:250,000 have been published by METC/DOE. These items are available free of charge from the Pennsylvania Geological Survey. The nine cross sections show all of the Devonian strata from the top of the Onondaga Group to the base of the Mississippian (where it is not eroded). There are three sections oriented approximately north-south, and six oriented approximately east-west. The organic-rich black shales and the Upper Devonian sandstones are designated on these cross sections by distinctive patterns. The two 1:250,000 scale maps show: (1) Drilling Depth to the top of the Onondaga Group, and (2) Gas Shows and Production from the Middle and Upper Devonian Organic-rich Shales.

In addition to these items, a third 1:250,000 scale map, Structure Contours on top of the Onondaga Group, and 39 1:1,000,000 scale maps are available on open file. The 1:1,000,000 scale maps represent isopach, structure contour, and lithofacies maps of the organic-rich shale-bearing units and isopach and lithofacies maps of the Upper

Devonian sandstones. Open file items may be examined, or copied in blue line form for the price of reproduction.

This material is available at the offices listed below: Pennsylvania Geological Survey, 1201 Kossman Building, Pittsburgh, PA 15222; Morgantown Energy Technology Center, U.S. Department of Energy, Eastern Gas Shales Project, P.O. Box 880, Morgantown, WV 26505.

GEOLOGISTS JOIN SURVEY

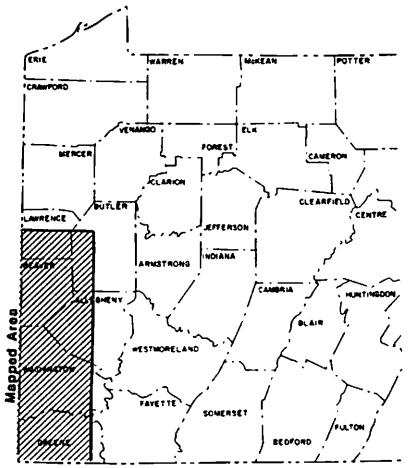
Denise Royer, a native of Lancaster County, Pennsylvania, has joined the staff of the Environmental Geology Division of the Pennsylvania Survey and is primarily responsible for maintaining the water well inventory program. Denise received her Bachelor of Arts degree in geology from the University of Colorado in 1976 and, following graduation, worked as a ceramic research scientist. Her professional interests include hydrogeology and resource management.

Clifford H. Dodge, also a native of Lancaster County, has recently accepted a position as coal geologist with the Geologic Mapping Division of the Survey. His responsibilities include areal appraisals of the bituminous coal resources and geologic mapping in western Pennsylvania. Cliff received his B.A. in the geological sciences from Lehigh University in 1972 and his M.S. in the geological sciences from Northwestern University in 1976. Cliff comes to the Survey with over three years of experience with the Water Resources Division of the U.S. Geological Survey, where he spent much of his time conducting water resources investigations and geologic mapping in northwestern Pennsylvania. His professional interests include the geology of northwestern Pennsylvania (particularly the Mississippian stratigraphy), coal geology, ground-water hydrology, and water geochemistry.

SOUTHWESTERN PENNSYLVANIA LANDSLIDE MAPS ON OPEN FILE

Maps of landslides and related features in an area covering most of Greene, Washington, Beaver, Lawrence, Allegheny, and Butler counties, as shown on the index map below, have been released by the U.S. Geological Survey and are on open file at the office of the Pennsylvania Geological Survey. The maps consist of 55 quadrangles (7 1/2-minute series, 1:24,000 scale) which by different symbols show active or recently active landslides, old landslides, slopes that are susceptible to sliding, slopes with small landslides, areas suscep-

tible to debris flows and debris avalanches, areas susceptible to rockfall, and areas least prone to landslides. The maps were prepared by W. E. Davies, J. S. Pomeroy, R. J. Hackman, and G. C. Ohlmacher of the U.S. Geological Survey.



The open file maps may be examined at the Pennsylvania Geological Survey, Executive House, 101 S. 2nd Street, Harrisburg, Pennsylvania 17101 and at the Pennsylvania Geological Survey, 1201 Kossman Building, 100 Forbes Avenue, Pittsburgh, Pennsylvania 15222. This material is in a form suitable for reproduction.

From one of our young citizens came this earnest request (handwritten exactly as shown):

Gentlemen:

I need this material for a very speachal reason. I must have all the imformation that I ask. I hope this isn't too much trouble but I need this information or I'll be in trouble. Please send me these things:

4 books on coal in Pa.
4 books on the strip mining
4 books of Common Fossils of Pennsylvania
4 books on Common Rocks & Minerals of Pa.

Please send this imformation or I'll be cent to the Princibles office.

Thank you for your kindness
Please Please

Yours
Truly

P.S. Please send it or my feelings will be hurt or I'll be crying in you know where.

Thank you again.

How could we deny such a plea? Another satisfied "customer."

ON THE DEMISE OF A TRIMERUS (DIPLEURA) DEKAYI

by John H. Way, Jr.[1]

To those of you who are even vaguely familiar with fossils called trilobites, the specimen of Trimerus shown in Figure 1 may look a bit strange. In order to understand his particular situation, let us look at these unique creatures.

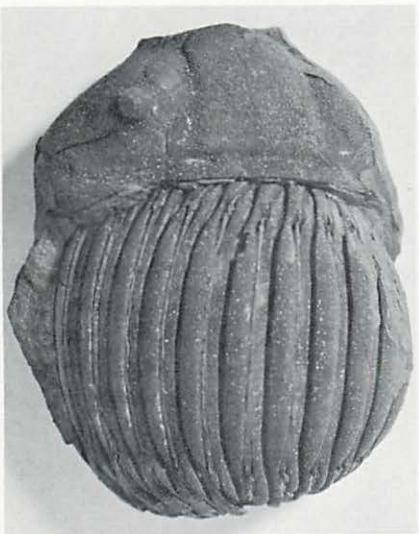


Figure 1. Specimen of Trimerus (Dipleura) dekayi from the Mahantango Formation near the Danville exit of I-80, Montour Co., Pa.

Trilobites belong to a large, highly varied and diversified group of animals called arthropods. This group is characterized by jointed arms, legs, and other appendages and comprises the insects, spiders, ticks, centipedes and millipedes, lobsters, crabs, shrimps, and barnacles. If we include both living and extinct animals, nearly 70% of *all* animal species belong to the arthropods; this involves at least 1 million species (Levi-Setti, 1975, p. 3). Originally the arthropods inhabited only the seas but, through time, they have adapted most efficiently to just about every possible environment imaginable. Statistically speaking, we are truly living in the age of arthropods.

Trilobites can be traced back 600 million years to the beginning of the Cambrian period when they suddenly appeared in the rock record as fully developed, specialized organisms. Unfortunately, no evidence for their presumed earlier existence has yet been found. It

[1]Pennsylvania Geological Survey

is probable that the ancestors of the trilobites had no hard parts to be preserved, but somewhere, Precambrian rocks must exist that contain traces of these arthropods.

During Cambrian time, trilobites specialized and diversified, and by the end of this period, 500 million years ago, they had reached their evolutionary peak. From that time on, it was all downhill, and they became extinct about 230 million years ago by the end of the Premian period. But for more than 400 million years the trilobite reigned supreme in the oceans that covered so much of the world at that time.

P. E. Raymond (1947, p. 47) noted that prior to the scientific study of trilobites, these natural curiosities were known as "petrified butterflies." Their elegantly ornamented coverings, striking symmetry, and relative rarity of complete forms has excited observers for decades and suggests that these creatures must have been truly remarkable. Trilobites tended to be small, averaging 2-7 cm (1-3 in.) in length, although fully-grown 3 mm- (1/10 in.) long specimens have been documented as well as some 70 cm (over 2 ft.) long, virtual giants among trilobites. Their habitat was exclusively marine, some choosing to crawl upon the sea floor, others were active swimmers, while still others channeled their talents in another direction and burrowed into the soft bottom sediments.

The name *Trilobita* originates from the three-fold division of the trilobite body into the axial lobe and the two more flattened, adjacent pleural lobes (Figure 2) and *not* from the separation of the skeleton into the three regions—the cephalon (head), thorax (body), and pygidium (abdomen) as is often, yet incorrectly, believed.

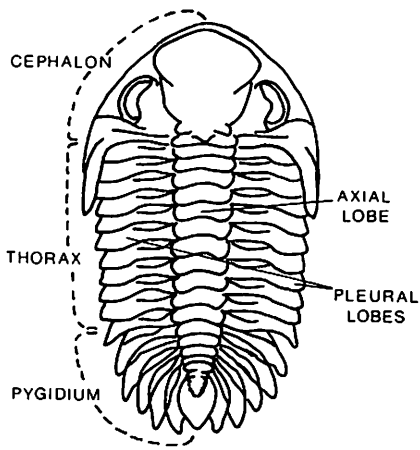


Figure 2. Trilobite skeleton with the three lobes indicated (1 axial lobe, 2 pleural lobes) as well as the 3-fold division of the entire skeleton.

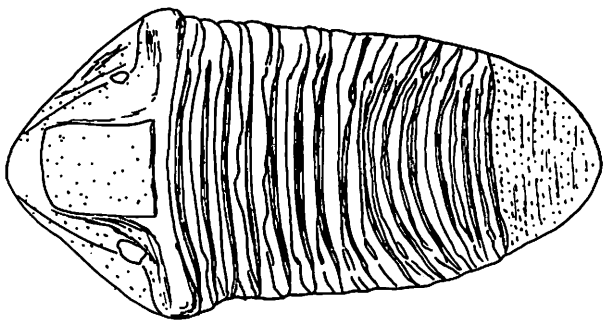


Figure 3. Trimerus (Dipleura) dekayi as it should look. Note that in this genus, the axial lobe is not present.

The body of the trilobite was completely encased in a protective chitinous skeleton (an exoskeleton). This exoskeleton was rigid, and growth of an individual could only take place through shedding or moulting of this armor covering. One individual, therefore, could have produced several fossils during his lifetime because it is this covering and not the soft parts of his body that becomes part of the fossil record (except under certain, very special conditions [Levi-Setti, 1975, p. 194, 195]). In addition, when the individual died, his final exoskeleton also had a chance for preservation.

This now allows us to speculate as to how our specimen met its fate. You will note that its head has rotated 90° and is now alongside the body (Figure 1, 3). The most probable explanation is that this fossil probably represents an exoskeleton that broke apart during the actual shedding process and was quickly burried and preserved in place.

This particular specimen was found at the base of the shale-chip debris slope developed in an exposure of Devonian age Mahantango Formation. Further information on the Mahantango Formation and its fossils is available in the Survey's report G 48 by R. L. Ellison and fossil collecting localities throughout the state are listed in another Survey publication, G 40, by D. M. Hoskins.

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GROUND WATER DIVISION

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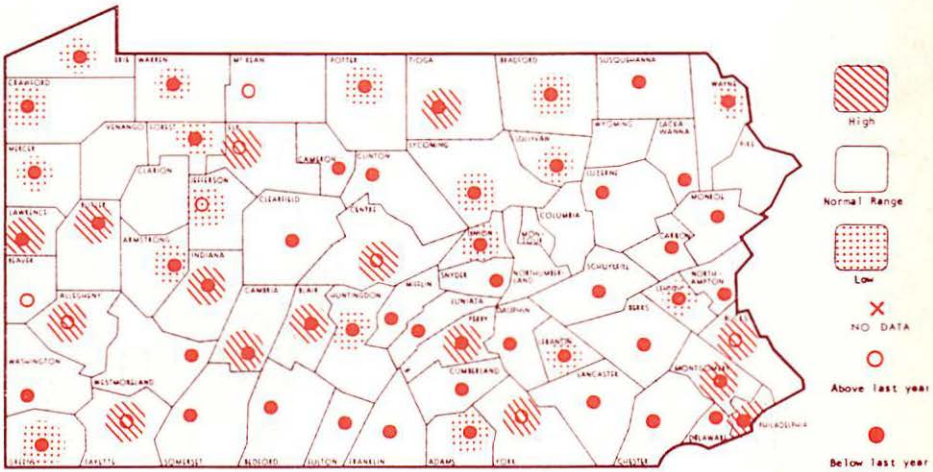
GROUND-WATER LEVELS
FOR
MAY 1979



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Address Corrections Requested

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