PENNSYLVANIA GEOLOGY

THE PENNSYLVANIA GEOLOGICAL SURVEY VOL. 10/2

COMMONWEALTH OF PENNSYLVANIA
Richard L. Thornburgh, Governor

DEPARTMENT OF ENVIRONMENTAL RESOURCES
Clifford L. Jones, Secretary

TOPOGRAPHIC AND GEOLOGICAL SURVEY
Arthur A. Socolow, State Geologist

CONTENTS

ON THE COVER: Not a pothole; just a sinkhole under Bullfrog Valley Road, near Hershey. This driver learned that sinkholes do have an impact upon man (See article, page 2). Photo courtesy of William H. Bolles.

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APRIL 1979

FROM THE DESK
OF THE
STATE GEOLOGIST . . .

THE LESSONS WE LEARN

Many years ago I was told that Harrisburg was utilized by industry and the government as a testing area for new products, services, and even movies. It appears that the testing has been extended considerably further, and includes such unplanned phenomena as floods and nuclear disasters. These traumatic events are, of course, too serious to be considered frivolously; I mention them here because we have just been provided with a reminder that there is a continued need to have on hand detailed maps and basic data on the geology, groundwater resources, and topography of all areas of our state.

At the very outset of the nuclear problem, there was a run on our supply of topo maps of the problem area as a variety of state and federal disaster and environmental agencies rushed to prepare appropriate response plans for the problem.

Then there was a call for all available groundwater data in a broad region of central Pennsylvania in order to evaluate the adequacy of water supplies for the various evacuation centers which were being planned.

As concern mounted over the possibility of a reactor core meltdown, attention was focused on the groundwater conditions at the plant site, as well as the bedrock geology at the site. The extent of health and environmental impacts of a potential meltdown were dependent in large measure on the nature of the bedrock and groundwater characteristics beneath the nuclear plant site.

Fortunately, we had available the required topographic, geologic, and groundwater maps and data. These are not data that can be prepared instantly in a crisis situation; our maps and reports are the result of detailed work by this agency over many, many years.

The lesson that applies directly to us from this tragic event is that we must keep on with our goal of completing and maintaining coverage of the entire state with up-to-date, detailed maps and data on the geology, topography, and groundwater resources. We hope for no more disasters of any type, but we must always be prepared; neither man nor nature is infallible. Fortunately, the very same data whose importance I stress here, also serves to support our economy, protect our environment, and maintain our way of life. There is a satisfaction in recognizing that our efforts and products are important; we are anxious to get on with the job.

Arthur A. Socolow

A Sinkhole Swallows A Road Before Our Very Eyes

by Alan R. Geyer and Arthur A. Socolow

If you wanted to watch a sinkhole actually develop, a rare sight of geology in action, Bullfrog Valley Road near Hershey was the place to be between Saturday, February 24 and Friday, March 2, 1979. A series of three photos shown here illustrates the progression of the sinkhole enlarging and the resulting damage progressively increasing. Starting as a depression at the side of the road, the road then collapsed. As one ambitious driver found out (by going around a barracade) the road was impassable. This is but one contemporary example of a long history of sinkhole development in Pennsylvania.

Sinkholes at best are a nuisance. To the farmer, they represent an area of the field that cannot be plowed, either too wet or an open hole. In some cases several acres are involved on one farm. To the borough or township, sinkholes often represent a large unexpected expenditure of money to repair the damage. To the home owner, sinkholes have meant loss of property, money, and even life.

What are sinkholes? Sinkholes show up at the surface when the soil has moved down into holes in the underlying rock. Over the past several thousand years, percolating rainwater has seeped into the ground and has partially dissolved the limestone and dolomite bedrock. The solution of limestone and dolomite has taken place along pre-existing cracks or fractures in the bedrock, resulting in solution cavities in the rock that range in size from hair-line cracks to large caves (see sketch, page 4). This solution is a continuous process which takes place at an extremely slow rate, but the system of openings swallowing the soil today has long been in existence and for all practical purposes will not change in our lifetime. The origin of solution cavities, channelways, and caves in dolomite and limestone in Pennsylvania is complex and varies with rock type, attitude of the bedding, amount and orientation of fracturing, as well as rate and direction of groundwater movement.

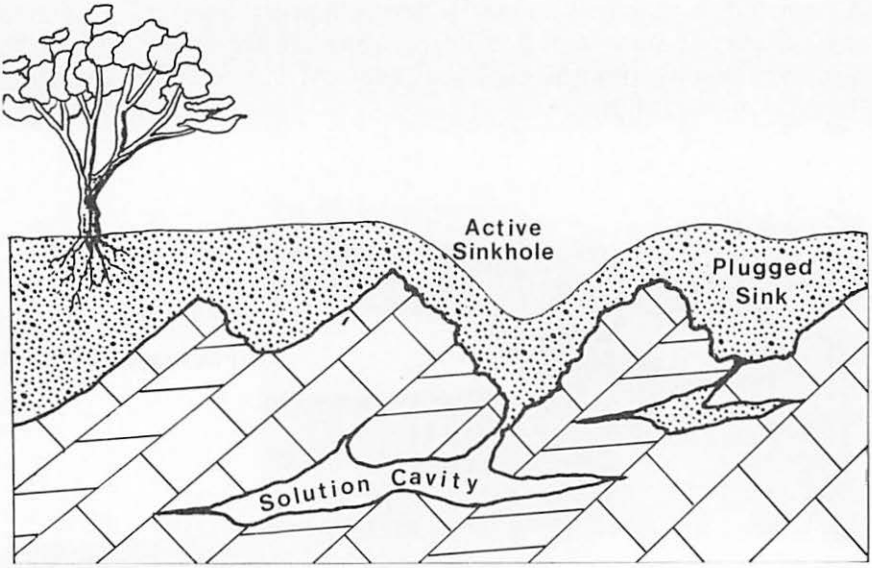
Most sinkholes show up at the surface during or shortly after a prolonged period of rainfall. The rain may cause the soil and clay which has previously filled a cavity in the rock to be washed quickly down into the open spaces in the limestone, forming a depression

A sequence of photos shows several sinkholes developing after a rain in the Hershey Valley; Bullfrog Valley Road, Derry Township, Dauphin County. Photos by Wm. Bolles. Arrow points to the same location in each photo.

Monday,
February 26, 1979

Thursday,
March 1, 1979

Friday,
March 2, 1979

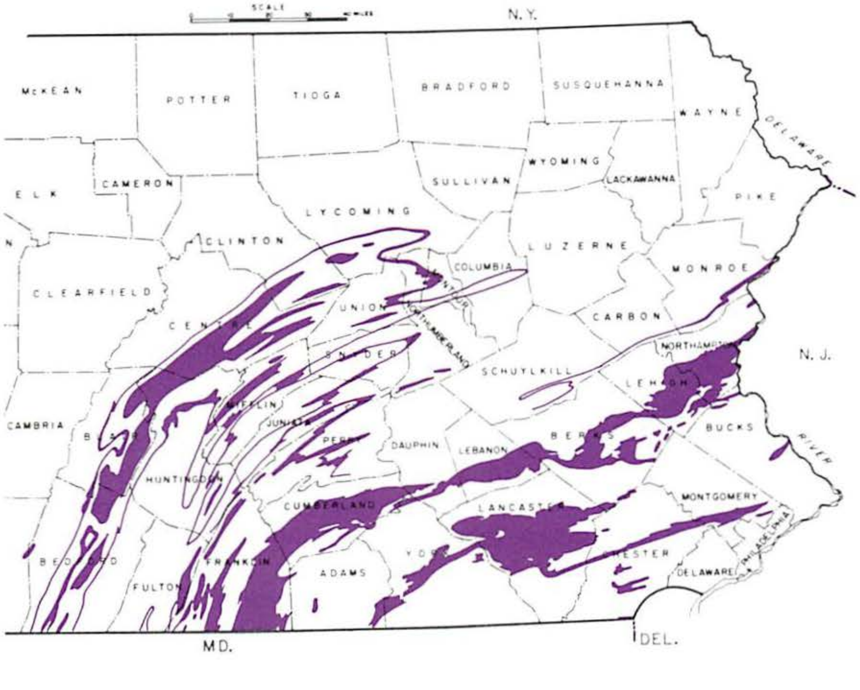


Sinkhole in the Lebanon Valley reportedly cost $90,000 to repair.

or sinkhole at the surface. In another situation the rain saturates the soil and rock which have existed as an arch over a subsurface opening, causing the arch to cave into the opening, forming a surface sinkhole. These are natural occurrences which happen often in Pennsylvania.

Man, in some cases, tends to accelerate the geologic, sinkhole-forming process. In urbanized areas, storm water runoff is often diverted by man into the soil overlying limestone bedrock. This water may effectively wash out soil plugs from solution cavities, resulting in surface collapse. Breaks in water mains and the use of french drains may also cause the same reactions. Large-scale pumping of groundwater from wells or quarries may lower the water table over an area which will cause the soils that had filled the solution cavities to wash out, resulting in surface sinkholes.

Where are sinkholes found in Pennsylvania? Wherever limestone occurs in Pennsylvania, you may expect to find sinkholes. However, some specific limestone valleys are more affected than others due to intense urbanization, rock type, and geologic structure. On the accompanying map these areas have been identified. Within each



Sinkhole in a residential backyard in the Lebanon Valley swallowed an entire car.

of these areas certain rock formations are most susceptible to cavern development and sinkholes. The Pennsylvania Geological Survey has studied these areas and their formations over the years and detailed geologic reports and maps have been published and are available.

Sinkholes in Pennsylvania generally range in diameter from a few feet to about 150 feet. In the southeastern part of the State the soil mantle involved in the larger of the sinks that have been investigated ranges from 50 to over 80 feet thick. In one sinkhole that was core drilled to 123 feet, the limestone and dolomite rocks were cavernous to a depth of 95 feet, with a 50-foot soil mantle present. Detailed groundwater studies in the Hershey and Lebanon Valley suggest that there are numerous fracture openings to 175 feet in depth.

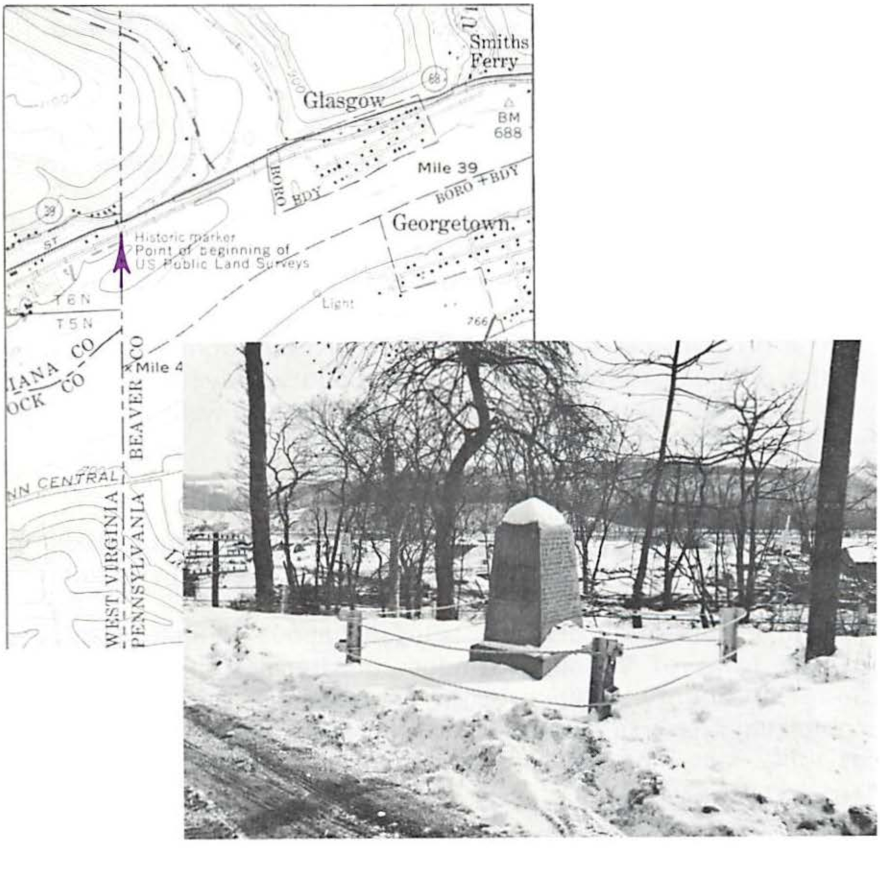
It is extremely difficult to detect openings in the rock prior to collapse. Drilling is excellent for the study of a small site but it is expensive when utilized on a large scale or regionally. Electrical resistivity profiles have proven effective for detecting some limestone openings but this method has depth limitations. To date, prior detection of sites likely to undergo surface collapse has not met with great success. The proper handling of storm water drainage in limestone terraines is the single most important precaution to reduce the likelihood of new sinkholes.

U.S. Public Land Survey Began In Pennsylvania

by Alan R. Geyer

The surveying of public lands in the United States had its beginning 1112 feet south of the monument along PA Route 68 west of Glasgow, Beaver County. On September 30, 1785, Thomas Hutchins, the first geographer of the United States, began his base line on the banks of the Ohio River.

This monument of St. Cloud (Minnesota) gray granite was originally erected in 1931 to mark the resurvey of the Pennsylvania-Ohio boundary line as established in 1786. In recent years the National Park Service has designated this site a registered National Historical Landmark. (Photo by Jesse Craft)



Continued Success In Gas Exploration

by Lynn Moser[1]
Robert G. Piotrowski[2]

Amoco Production Company and UGI Development Corporation of Valley Forge, PA, whose gas-utility division serves customers in eastern Pennsylvania, began an extensive exploratory drilling program in Pennsylvania in May of 1977. Nine exploratory wells were drilled in 1977; four were producers and five were dry holes (Oil and Gas Journal, February 20, 1978). The four producers indicated good potential in Pennsylvania and the program was continued into 1978.

Nine wells were drilled in 1978; four were completed as producers, two were completed as dry holes, and three are currently drilling. Due to the continued success of the project, three additional wells have been located in Somerset County with drilling planned for 1979.

In the Amoco-UGI program to date, out of a total of 18 wells drilled, eight are successful, seven are dry holes, and three are being drilled. The eight producing wells have flow rates ranging between 14 mcfd and an estimated 37,000 mcfd.

The Oriskany (Lower Devonian) Formation has been the most successful target with six wells producing from this horizon. One well in the program produces from the Tuscarora (Silurian) and one from the Upper Devonian.

The program has been concentrated in four counties. Two wells in the program are located in Centre County, Fayette County has two wells, Somerset County has a total of sixteen wells or locations, and Westmoreland has had one well drilled.

1978 Completions

Three wells were begun in 1977 but not officially completed until 1978. These include the B-1 Berwind Corp., the #2 Texasgulf, and the #1 Donald McCann.

The B-1 Berwind Corp. well is located about 6½ miles southwest of the town of Windber, Windber quadrangle, Shade Township, Somerset County. Drilling began on December 4, 1977, and was completed December 8, 1977, as a dry hole reaching a total depth of 1,112 feet. The well was permitted to the Oriskany Formation

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at a depth of 8,700 feet but plugged on December 23, 1977, due to revised seismic data received by the operator.

Drilling began on a development well, the #2 Texasgulf, in the Devil's Elbow field on June 8, 1978, and was completed July 7, 1978. The well was completed as a dry hole at a total depth of 13,059 feet in the Tuscarora (Silurian) Formation. The #2 Texasgulf is located about ½ mile southwest of the #1 Texasgulf, Snow Shoe southeast quadrangle, Boggs Township, Centre County. The apparent discovery well, the #1 Texasgulf, has an estimated natural flow rate of 37,000 mcfd but has not been officially completed. The well remains a tight hole to date.

(1) B-1 Berwind
TD - 1112'
D&A

(2) #2 Texasgulf
TD-13,059' Tuscarora
D&A

(3) #1 Texasgulf
TD-11,187' Tuscarora
IP-37,000 Mcfd - N

(4) #1 McCann
TD-3,600' Upper Devonian
IP-14 Mcfd - F

(5) #1 Spory
TD-8,950' Oriskany
IP-250 Mcfd - F

(6) #1 Yoder
TD-9,067' Oriskany
IP-1,380 Mcfd - F

(7) #1 Maude Mountain
TD-8,150' Oriskany
IP-500 Mcfd - F

(8) #1 Hemminger
TD-8,902' Oriskany
IP-2,600 Mcfd - F

(9) #1 Engleka
TD-9,198' Oriskany
IP-4,100 Mcfd - F

(10) #1 Naugle
Proposed Depth - 9,100'

(11) #1 Ott
TD-9,000' Oriskany
IP-1,430 Mcfd - F

(12) Commonwealth of PA #111-A
Proposed Depth - 9,000'

(13) #1 Barron
Unofficial TD-8,852'
Oriskany

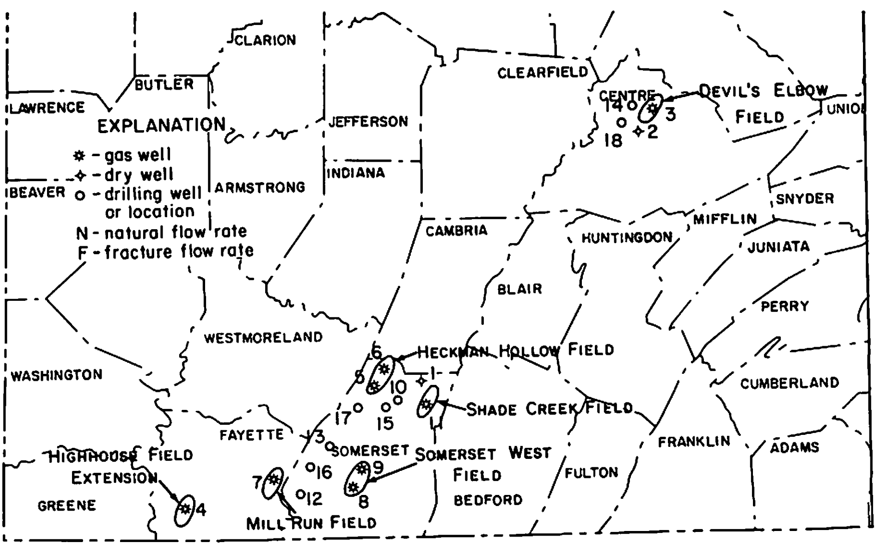
(14) #1 C & K Coal
Proposed Depth - 11,500'
Amoco-Phillips Well

(15) Edward A. Kirk
Proposed Depth - 8,600'

(16) Commonwealth of PA
Proposed Depth - 3,150'

(17) #1 Stemmler
Proposed Depth - 3,600'

(18) #1 C & K Coal Co/Gas Unit
Proposed Depth - 11,500'
Amoco-Phillips Well



The #1 Donald R. McCann is located about 3½ miles northwest of the town of Smithfield, Smithfield quadrangle, Nickolson Township, Fayette County. The successful Upper Devonian well is an extension of the Highhouse field, producing gas at 14 mcfd from 3,462 feet after fracturing. The total depth of the #1 McCann is 3,600 feet.

Other wells which were located and completed in 1978 include the #1 Spory, the #1 Maude Mountain, and the #1 Hemminger.

The #1 Spory is located about 8 miles northwest of the town of Boswell, Boswell quadrangle, Conemaugh Township, Somerset County. It is a development well in the Heckman Hollow field which was discovered in 1977 by the #1 David Yoder well, also part of the Amoco-UGI program. After fracturing, the Spory is producing at a rate of 250 mcfd from a horizon located in the Oriskany (Lower Devonian) Formation between 8,840 feet and 8,866 feet. Drilling began on August 19, 1978, and was completed on September 27, 1978, at a total depth of 8,950 feet.

The #1 Maude Mountain, located 5 miles north of the Ohiopyle field and 10 miles southeast of the town of Connellsville, Mill Run quadrangle, Springfield Township, Fayette County, is the discovery well of the Mill Run field. After fracturing, a flow rate of 500 mcfd was recorded from the Oriskany Formation at a depth of 7,946 feet. Drilling began on May 24, 1978, and was completed August 17, 1978, at a total depth of 8,150 feet.

The #1 Hemminger, located a few miles southwest of Somerset, Murdock quadrangle, Somerset Township, Somerset County, is a successful development well in the Somerset West field, discovered in 1977 by the #1 Engleka. Drilling of the Hemminger well commenced on July 15, 1978, and was completed September 6, 1978, at a total depth of 8,902 feet. After fracturing, a flow rate of 2,600 mcfd was recorded from the Oriskany Formation at a depth between 8,726 feet and 8,820 feet.

Three wells are currently being drilled and are expected to be completed in 1979. These are the #1 Naugle Gas Unit, the Commonwealth of PA #111-A, and the #1 Dale S. Barron, all located in Somerset County.

The #1 Naugle Gas Unit is about 4½ miles southwest of the town of Windber, Hooversville quadrangle, Shade Township, Somerset County. The #1 Naugle is a development well in the Shade Creek field which was discovered in 1977 by the #1 Ott well, also part of the Amoco-UGI program. Drilling of the Naugle began on October 28, 1978. On January 12, 1979, the well had reached 9,090 feet with a scheduled total depth of 9,100 feet in the Oriskany Formation.

Drilling began on October 6, 1978, at the Commonwealth of PA #111-A and had reached a depth of 8,278 feet by December 22, 1978. The expected total depth is 9,000 feet in the Oriskany Formation. The well is about 8 miles northeast of Ohiopyle, Kingwood quadrangle, Lower Turkeyfoot Township, Somerset County.

Drilling of the #1 Dale S. Barron well began on December 2, 1978. It is located about 5 miles west of Somerset and about 4 miles northwest of the Somerset West field, Bakersville quadrangle, Jefferson Township, Somerset County. This new field wildcat has been unofficially completed as a producer with an estimated natural flow rate of 3,000 mcfd at a total depth of 8,852 feet in the Oriskany Formation.

Three additional locations have been selected in the Amoco-UGI program for 1979. These proposed wells are the #1 Edward A. Kirk, the #1 Commonwealth of PA, and the #1 Stemmler, all located in Somerset County.

The #1 Edward A. Kirk location is in the Stoystown quadrangle, Stoneycreek Township, Somerset County. The scheduled target is the Oriskany Formation at a total depth of 8,600 feet.

The Upper Devonian is the scheduled target formation for two locations, the #1 Commonwealth of Pennsylvania and the #1 Stemmler.

The #1 Commonwealth well location is about 2 miles directly west of Laurel Hill State Park, Kingwood quadrangle, Middlecreek Township, Somerset County. The scheduled total depth is 3,150 feet.

The #1 Stemmler well location is about 3 miles northeast of Jennerstown, Boswell quadrangle, Jenner Township, Somerset County, and is scheduled for a total depth of 3,600 feet.

Two other wells, #1 C & K Coal and the #1 C & K Coal/Gas Unit, are significant deep tests (see Figure 1) but are not part of the Amoco-UGI drilling program. Both wells are farmouts to Amoco Production Co. from Phillips Petroleum Co. Drilling of the #1 C & K Coal well began on April 20, 1978, and at the time of writing was reported at a depth of 11,170 feet with an expected total depth of 11,500 feet in the Tuscarora (Silurian) Formation. The well is located about 1½ miles northwest of the #1 Texasgulf well in Snow Shoe southeast quadrangle, Boggs Township, Centre County. The #1 C & K Coal/Gas Unit location is about 1 mile southwest of the #1 C & K Coal well. The scheduled depth of this well is 11,500 feet which is also in the Tuscarora Formation.

Summary

In the Amoco-UGI program, 18 wells have been drilled, eight successful, seven dry holes, and three drilling wells. The eight successful wells have reported flow rates between 14 mcfd and 37,000 mcfd. Location for three additional wells have been named for 1979.

By far the most successful well of the entire program is the #1 Texasgulf, located in Centre County. The well is producing from the Tuscarora (Silurian) Formation at an estimated natural rate of 37,000 mcfd.

The success of the Amoco-UGI exploratory program, both in 1977 and 1978, indicates excellent natural gas potential in Pennsylvania and exploratory activity in the state is expected to continue.

Rare Fossil Fish Surfaces At The William Penn Memorial Museum

by Donald Baird[1]

Of all the rare fishes living today perhaps the most notorious is the coelacanth, (pronounced SEE-la-canth) *Latimeria chalumnae.* People who wouldn't know a hake from a hagfish have heard of the five-foot, steel-blue monster that was hauled from the ocean off East Africa in 1938 and proved to be the living representative of a race that scientists had thought to be extinct since the reign of *Tyrannosaurus rex.* Discovery of a living coelacanth of course sparked renewed interest in its fossil relatives, particularly as the coelacanths were an offshoot from the line of Devonian lobefin fishes that evolved into amphibians and thus became, ultimately, our own ancestors. *Latimeria* is thus our closest living relative in the fish kingdom.

As additional specimens of *Latimeria* were caught scientists were able to analyze its anatomy in detail. The new information they gained was of course invaluable in interpreting the anatomy and way of life of the ancient coelacanths, of which only the hard parts—skeletons, scales, and in some cases the calcified swim-bladder—had been perserved as fossils.

Students of fossil coelacanths necessarily zeroed-in on Pennsylvania, for one of the best-known members of the group, *Diplurus*

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newarki, had first been described on the basis of skeletons found in the gray Triassic argillite near North Wales in Montgomery County; additional specimens have been collected near Gwynedd and elsewhere in the state. The greatest number of *Diplurus* fossils come from New Jersey, particularly from the Granton Quarry in North Bergen and the excavation for Firestone Library on the Princeton University campus, where concentrations as high as 12 coelacanths per square foot occurred. When restudied by Dr. Bobb Schaeffer of the American Museum of Natural History (figure 1), *Diplurus* proved to be remarkably similar in basic structure to its living relative, though of course distinctive in detail, as might be expected in fishes separated by 190 million years of time.

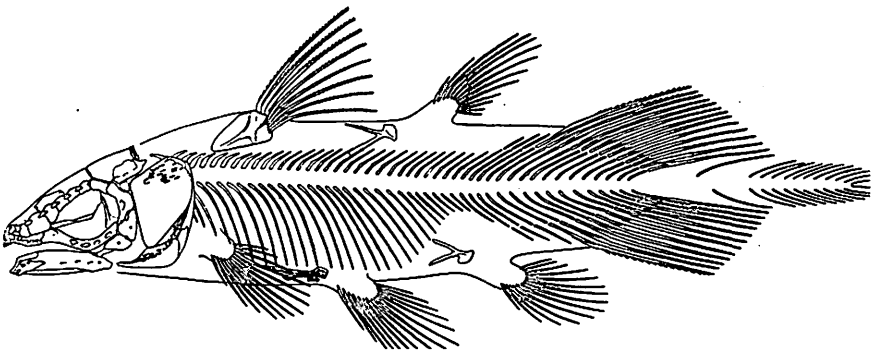

Figure 1. Skeleton of *Diplurus newarki* as reconstructed by Dr. Bobb Schaeffer.

One significant difference is that, although today's living *Latimeria* is a deep-water marine fish, *Diplurus* was an inhabitant of fresh-water lakes. It was by far the most abundant inhabitant of ancient Lake Lockatong, which once extended from southeastern Pennsylvania to what is now the Hudson River. A survey of their history shows that fresh water was the original home of the coelacanths and their preferred habitat until Jurassic time, when some members of the group succeeded in establishing themselves in marine waters—where the last survivor is found today.

Although coelacanth fishes are known from as far back in time as the Devonian period, our Triassic friend *Diplurus* was until recently the only one found in Pennsylvania. Considering the extensive deposits of Paleozoic fresh-water sediments in the state, it seemed inevitable that a pre-Triassic coelacanth would eventually be found here. And sure enough, one has come to light: not on an outcrop but in a museum drawer at the William Penn Memorial Museum, where it had lain unrecognized for a hundred years.

The specimen illustrated here (figure 2), the first Pennsylvanian coelacanth from Pennsylvania, was collected about 1877 by the Hon. I. F. Mansfield at his coal mine near Cannelton in Beaver County. There is hardly space here to do justice to the contributions made by this remarkable man, who was so dedicated a fossil-collector that I sometimes wonder if he didn't regard the coal as just a byproduct of his mine. Well, probably not—a 12-foot seam of beautiful cannel is nothing to sneeze at—but the shale immediately underlying the cannel proved to be a treasurehouse of plant and animal fossils which Mansfield devoted himself to saving for science.

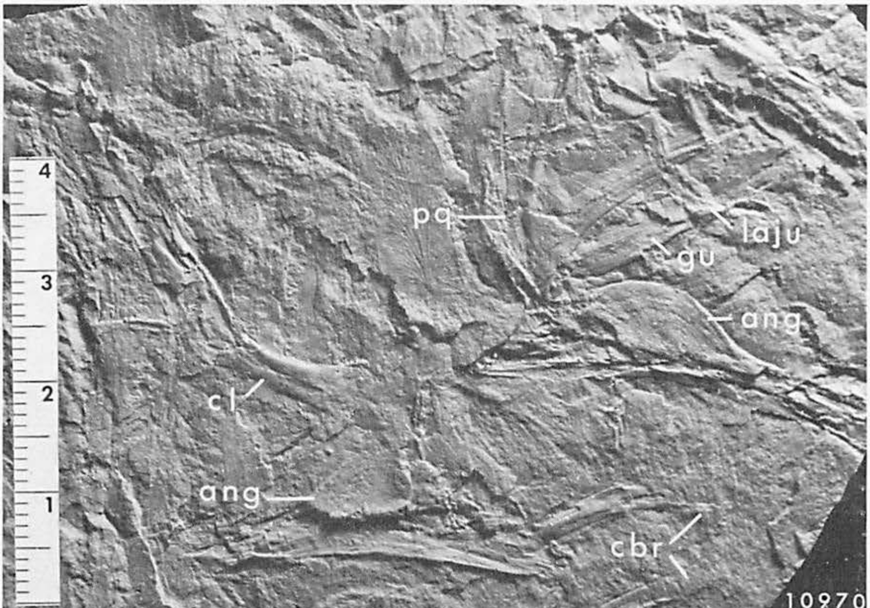

Figure 2. Disarticulated bones of the Cannelton coelacanth include the upper jaw (pq) and lower jaws (ang), a chin plate (gu), two gill-arches (cbr), cheek bone (laju), and a shoulder blade (cl). Scale is 4 centimeters long. William Penn Memorial Museum No. 10970.

The splendid collections now housed at the Smithsonian, Harvard, Princeton, and the William Penn Memorial Museum (among other institutions) bear lasting witness to his zeal.

Subsequent studies by geologist Frank W. DeWold (1929) showed that the Cannelton deposits had been laid down in an oxbow-shaped channel during the Upper Kittanning coal-forming cycle in mid-

Pennsylvanian time, about 300 million years ago. Most of the fossils preserved are seed-ferns and other representatives of the coal-swamp flora that is so familiar to Pennsylvania fossil-hunters. But there are also abundant eurypterids (commonly called "sea-scorpions" but in this case strictly fresh-water), cockroaches and other insects, salamander-sized and snake-like amphibians, and a variety of fishes.

You can hardly blame Mansfield or the State Survey paleontologists of the last century for not recognizing the coelacanth specimen, for it doesn't look like a fish at all, not even one the cat dragged in. As just another nondescript fossil it disappeared into dead storage with the rest of the Second Survey collection. Only in recent years, when the William Penn Memorial Museum assumed responsibility for the old Pennsylvania Survey collections, was curator Donald Hoff able to unpack them and make them accessible for study. No doubt it was serendipity that led me, while visiting Harrisburg to study Triassic amphibians and reptiles, to discover this unexpected and long-concealed treasure.

Although the bones of the coelacanth's head and shoulder girdle have come apart and are strewn about on the slab, each of them has a highly characteristic shape that is instantly recognizable to anyone who has worked with fishes of this type. As it happens, I had collected a good many specimens of the same species at a famous fossil locality in Ohio: the Linton mine dump near the mouth of Yellow Creek on the Ohio River near East Liverpool. These Linton coelacanths, *Rhabdoderma elegans* (Newberry), lived about a million years later than the one from Cannelton and were probably its descendants.

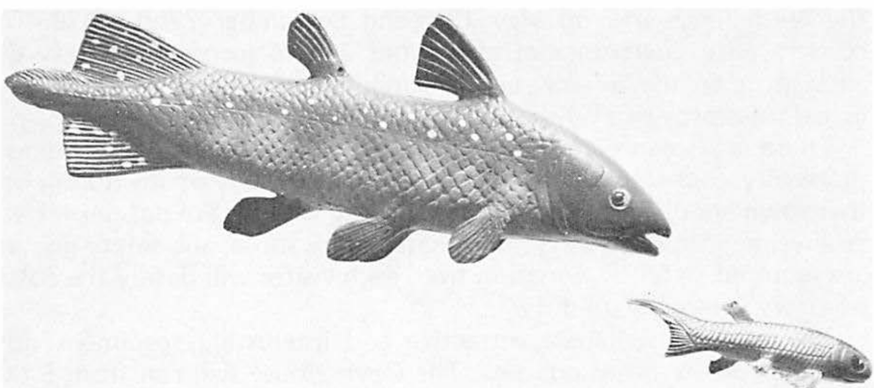

Figure 3. *Rhabdoderma* about to pounce on *Haplolepis,* as modeled by the Rush Studio for the William Penn Memorial Museum.

Rhabdoderma elegans was not a large fish—about six inches was its usual adult length--but it had a voracious appetite out of proportion to its size. The evidence for this can be seen in a specimen from Linton (PU 19299 in the Princeton collection) that was fossilized with a smaller fish in its gullet. The victim in this case was the palaeoniscoid *Haplolepis tuberculata,* a diminutive and distant relative of today's diamond-scaled garpikes. It appears that the coelacanth had gulped its prey head-first and had swallowed all but the tail when something went wrong: either the palaeoniscoid was more than it could manage or, more likely, the coelacanth was itself snapped up by some larger predator while straining to engulf its victim. The *corpus delicti* of this little coal-swamp tragedy provides scientists with their first evidence of what *Rhabdoderma* ate—or at least what it *thought* it could eat (figure 3).

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A Quarry Invitation

William O. Faylor, Jr., President of Faylor-Middlecreek, Inc., operator of the Winfield Quarry, has sent this generous message to all their mineral club friends:

Faylor-Middlecreek, Inc., will continue open house visitations at the Winfield Quarry on May 19th and September 22nd, 1979. To comply with governmental regulations and to insure the safety of all visitors to the quarry, all participants must adhere to the established rules provided by the company.

There is a steep climb into and out of the quarry and anyone not physically able to climb the steep hills coming out of the quarry on their own should not walk down. Visiting vehicles are not permitted at anytime into the quarry. Hard hats, safety shoes, and safety glasses are required. A $1.00 donation from each visitor will defray the costs of safety personnel on duty.

The quarry has some attractive and interesting specimens not found in many other quarries. The Open House will run from 8:00 a.m. to 4:00 p.m.; there will be a food stand in the parking lot. Those planning to attend should advise the company in advance. Faylor-Middlecreek Inc., Winfield, PA 17889.

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TOPOGRAPHIC DIVISION

In Cooperation with The U.S. Geological Survey

GROUND WATER DIVISION

In Cooperation with The U.S. Geological Survey

GROUND-WATER LEVELS

FOR

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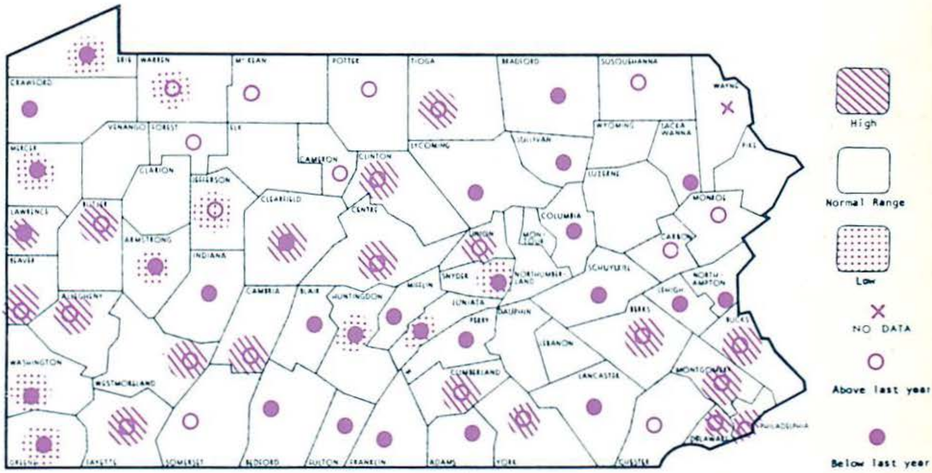

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