PENNSYLVANIA GEOLOGY

THE PENNSYLVANIA GEOLOGICAL SURVEY VOL. 16/5

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

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ON THE COVER: The near-vertical streaks are Devonian age Venango sandstone along Pa. Route 59 beside Allegheny Reservoir, 0.2 mi east of Kinzua Dam, Warren County. The *Skolithos* fossils are common in clean sandstones that were deposited as offshore bars. The sandstone is important as an oil and gas producer. Photo by Tom Berg.

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FROM THE DESK
OF THE
STATE GEOLOGIST

SECURITY AND KNEE JERKS

Would the U.S. drop its military defense program if it were demonstrated that it is not economical? Probably not, since there is a consensus in our nation that national security is essential. Yet a recent new announcement indicates that another vital security component, the availability of domestic oil and gas, is receiving a major curtailment in the name of economic justification.

The nation's only commercial scale synthetic fuels plant, the Great Plains Coal Gasification Project in North Dakota, is scheduled to be shut down by its corporate operators because the federal government has decided to discontinue its financial underwriting since it has become cheaper to import oil than to manufacture synthetic fuels. This decision overlooks the fact that research and development of synfuels was intended not merely to combat the rising prices of oil and natural gas, but more importantly, to establish a security cushion for the U.S. to be able to take care of its essential oil and gas needs if cut off from foreign sources.

Even in the face of declining oil and natural gas prices and a temporary oil and gas "glut," the world is well aware of the questionable reliability of America's foreign sources upon whom we are again approaching a 40% dependency for oil and gas. Despite the fact that U.S. exploration and occasional discoveries persist, the continuing trend of oil and gas reserves in the U.S. is down! The availability of a technologically operated synfuel program is a security development which should not be measured only in dollars. And Pennsylvania, with its large resources of coal that is the new raw material for synfuels, has a significant stake in this issue. Science magazine (8/16/85) quotes Clifford W. Rackley on the federal curtailment, "We have proceeded in a knee-jerk reaction in the past. We are acting in a knee jerk fashion now."

Arthur A. Socolow

KEYSTONE LIME COMPANY, INC.

Making the Most from What's Available

Keystone Lime Company, Inc. selectively mines a nearly flat-lying limestone and sandstone sequence in the Allegheny Plateaus physiographic province in southern Somerset County. Here, Negro Mountain Anticline brings Mississippian age rocks to the surface in a southwest-northeast-trending topographic and structural high. Two quarries and one underground mine near Mt. Davis (Pennsylvania's highest elevation, 3213 feet) provide crushed stone and agricultural limestone for Pennsylvania, Maryland, and West Virginia.

The ancestral company was started around 1930 as a "burnt-lime" operation with its first quarry and 7 kilns (now abandoned) located near Niverton. The active Galley Quarry, located near the southeast corner of High Point Lake at Savage (lat. 39°46′33″N, long. 79°12′24″W), was developed in the 1950's. Selective mining of Mississippian-age strata provides multiple end-use products from the various rock types available. After removing Mauch Chunk red shale overburden, 8 to 10 feet of Deer Valley Limestone is selectively quarried for the production of agricultural limestone and PennDOT approved, Type A, Skid Resistance Level (SRL) L aggregate (SRL L aggregate can only be used in bituminous surfaces with average daily traffic counts of 1000 or less). This limestone is characterized as a light-gray calcarenite (clastic sand-sized limestone). Flint (1965) identified the calcite fraction as containing 36% clastic granular calcite, 33% detrital microfossils, and 26% microcrystalline cement, and designated this quarry as the type section for the Deer Valley Limestone. The limestone contains a quartz-rich layer of variable thickness at the top of the sequence.

Directly beneath the Deer Valley Limestone is the Loyalhanna Formation characterized here as a grayish-red, conspicuously cross-bedded quartzose limestone averaging about 40 feet thick. The Loyalhanna's uncommon red color, which is confined to southern Somerset County, is attributed to interstitial hematite and hematite coatings (Flint, 1965). This limestone is an important bedrock aggregate and railroad ballast source in western Pennsylvania. It provides most of the tonnage produced by Keystone Lime. It is recognized as important because of PennDOT's Type A, SRL H designation, which permits its use in bituminous road surfaces having daily traf-

fic counts of up to 20,000. This sandy limestone has one of the highest coefficients of friction for crushed stone. It is second only to a few sandstones that have a SRL E rating. Both the Loyalhanna Formation and the Deer Valley Limestone are interpreted to represent a somewhat turbulent shallow marine environment of deposition which records a transgressive marine event (Flint, 1965).

Subjacent to the Loyalhanna Formation, the Burgoon Sandstone (Pocono Formation) is mined at the Galley Quarry principally as a high-friction aggregate source (SRL E). This uppermost part of the Burgoon sequence is generally characterized as a light-gray to light-greenish-gray, fine-to-medium grained sandstone containing some minor varicolored shales and siltstones (Figure 1). Mineralogically, the sandstone contains major quartz, minor mica, chlorite, feldspar, and trace pyrite. Ancient stream channels, visible in the 20-foot-high quarry faces, attest to a fluvial environment of deposition. Locally, a black shiny interstitial carbon or bitumen is present in some sandstone beds. Flint (1965) reported that Koppe studied a 1- or 2-inch-thick coal from this formation at Fairhope. There is also, apparently, a thin sedimentary hematite ore bed near the top of the Burgoon Sandstone. It was not observed in place, but is believed to be less than two inches thick. Some vague fossil replacements are visible, and this ore bed may be possibly related to a local unconformity between the overlying Loyalhanna Formation and the Burgoon Sandstone.

Figure 1. Burgoon Sandstone faces at the Galley Quarry of Keystone Lime Company, Inc. This south-looking view shows several fluvial channels in the 20-foot-high sandstone faces. 1 = Loyalhanna Formation, 2 = Burgoon Sandstone, 3 = Deer Valley Limestone.

Most of the available reserves of the Deer Valley and Loyalhanna Formations have been depleted from the Galley Quarry, which is now chiefly a source of high-friction aggregate (Burgoon Sandstone). However, the Eichorn Quarry, located about 2 miles south of Savage on Christner Hill (lat. 31°44′42″N, long. 79°12′24″W), has been developed in similar Deer Valley and Loyalhanna limestones (Figure 2). Large reserves are available from this location, as is the underlying Burgoon Sandstone, which is not presently being mined. State-of-the-art automated crushing and a computerized hot-mix plant are located on the Eichorn site. Only 5 people are required to run both plants.

The Peck Mine, located 1 mile northeast of Savage on the west-facing slope of Mount Davis (lat. 39°47′43″N, long. 79°11′37″W), is developed in the Wymps Gap Limestone. The mineable sequence of Wymps Gap is characterized as a medium bluish gray, medium-to-

Figure 2. Quarry faces of the Eichorn Quarry of Keystone Lime Company, Inc. Notice the conspicuous trough and minor planar cross-stratification of the quartz-rich Loyalhanna Formation. The floor of the quarry is the upper part of the Burgoon Sandstone. 1 = Mauch Chunk Formation (overburden consisting of red shales, minor siltstones and sandstones), 2 = Deer Valley Limestone, 3 = Loyalhanna Formation, 4 = Burgoon Sandstone.

finely crystalline, fossiliferous marine limestone. Above and below this 10-foot-thick, thick-bedded limestone are fossiliferous shale and limestone interbeds. The most abundant fossils are brachiopods, but bryozoans, trilobites, and crinoids also occur. Hoskins and others (1983) further describe the fossil assemblage at this site. This limestone stratigraphically occurs about 80 feet above the Deer Valley Limestone. The Wymps Gap, Deer Valley, and Loyalhanna limestones are all correlatives with the Greenbrier Formation of West Virginia (Berg and others, 1983 and Flint, 1965). The underground room-and-pillar mine (rooms about 35 feet by 35 feet and pillars about 50 feet by 50 feet) removes about 8 feet of the basal, thick-bedded fossiliferous limestone as a source of high-grade agricultural material, but is worked only in the winter months.

In general, Keystone Lime's marketing area for aggregate, principally from the Loyalhanna, covers about a 30-mile radius, whereas the agricultural products, produced from the Deer Valley and Wymps Gap, stretch to about a 50-mile radius, and the top-quality, high-friction aggregate (SRL E), produced from the Burgoon Sandstone, reaches out the farthest, to about a 60-to-70-mile radius. Combined annual production of these operations is approximately 300,000 tons, with the majority coming from the Loyalhanna portion of the Eichorn Quarry. Innovative mining techniques and state-of-the-art processing plants assure a continued supply of quality construction and agricultural products for the Pennsylvania, Maryland, and West Virginia markets.

We thank Mark Folk, President, Keystone Lime Company, Inc., for his time and cooperation in preparing this article.

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OIL AND GAS BASE MAPS COMPLETED

As announced previously (Pennsylvania Geology, v. 16, no. 2, p. 12-13, April, 1985) the Pennsylvania Geological Survey, Oil and Gas Geology Division, is making available to the public a new series of 7½ minute oil and gas base maps. At the time of that announcement, the series included only the maps in the upper half of the oil and gas fields area of western Pennsylvania. The series is now complete, covering all of western Pennsylvania's oil and gas fields and the areas of central and eastern Pennsylvania where exploratory drilling has occurred. The new series is accessible as ozalid ("blueline") reproductions of standard U.S. Geological Survey 7.5-minute topographic maps overprinted with well symbols and identifying numbers. The topographic portion of each map is subdued to let the well information stand out, but is still legible on a blueline reproduction.

The 7.5-minute base maps replace, rather than supplement, the 15-minute series of base maps that have been sold through the State book Store since 1970. All of the old 15-minute maps, titled "Oil and gas well base map of the ... 15′ quadrangles" are now out-of-print and will no longer be sold by the State Book Store. The 7.5-minute maps are available on "open-file" at the Oil and Gas Geology Division in Pittsburgh.

When requesting the maps please provide the 7.5-minute topographic *map name* of each map desired. To determine map names refer to "Pennsylvania Index to Topographic and Other Map Coverage" published by the U.S. Geological Survey and available free of charge by writing to our Bureau offices or from the Branch of Distribution, U.S.G.S., 1200 S. Eads St., Arlington, VA 22202.

The Index to the new maps may be obtained by contacting the Oil and Gas Geology Division, 7th Floor Highland Building, 121 S. Highland Avenue, Pittsburgh, PA 15206, telephone number (412) 665-2155, between 8:00 AM and 4:00 PM weekdays.

Oil and gas base maps cost $3.40 per copy plus shipping costs and are ordered through A. H. Mathias & Co., Inc., 950 Penn Avenue, Pittsburgh, PA 15222 or by contacting the Division offices.

CHLORITE-REPLACED FOSSILS IN UNION COUNTY

by Jon D. Inners
Pennsylvania Geological Survey

Of the many types of fossil preservation the most interesting to the mineralogist is replacement. This manner of fossilization involves the solution of original skeletal substance (generally calcite or aragonite in the case of invertebrate shells) and the simultaneous deposition of some other mineral substance within the void thus formed. The medium of dissolution and deposition is highly mineralized water, either occurring within the interstices of unconsolidated deposits at shallow depths or in pores and fractures of deeply buried and rigidly indurated sedimentary rocks. In central Pennsylvania, the most common minerals replacing originally calcitic or aragonitic shells are quartz (in limestones), pyrite (in clay shales), and hematite (in ironstones and ferruginous limestones). Adding to this list of secondary minerals in fossils, the author recently discovered a rather unusual locality in northern Union County where invertebrate shells in the Lower Silurian Rose Hill Formation are replaced by a mixture of quartz and chlorite (a greenish, scaly mineral).

The "chloritized" fossils are found in a borrow pit at Nittany Mountain Campground, located on the north side of Millers Bottom Road (T-442) in White Deer Township, 4.6 mi west-northwest of New Columbia (41°02′57″N/76°57′12″W, Allenwood quadrangle; Figure 1). Nittany Mountain, one of several prominent anticlinal mountains which die out eastward across northern and western Union County, lies just to the north of the site. The owner of Nittany Mountain Campground, Mr. Jack Ficks, periodically removes shale from the pit for use in road paving and campsite foundations. He welcomes collectors and students, asking only that they check in at the office before proceeding to the pit.

Exposed in the borrow pit are poorly fissile, yellowish-gray and dusky yellow, fossiliferous clay shales containing a few lenticular interbeds of olive-gray, very fine grained sandstone. Fracture surfaces in both clay shales and sandstones have conspicuous coatings of bluish-black iron-manganese oxide and bright reddish-orange iron oxide. Bedding in the pit dips 48 degrees toward S4E on the south limb of the Nittany Mountain anticline. Many bedding surfaces exhibit faint, closely spaced nonmineralized grooves ("slickenlines")

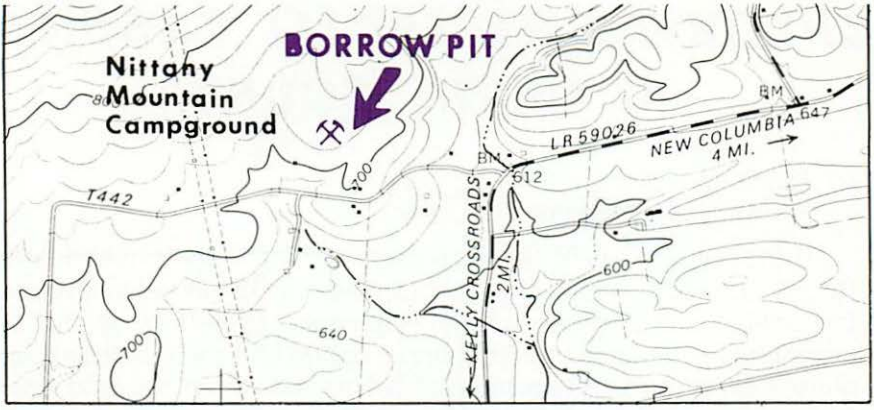

Figure 1. Location map.

formed by slippage of the shale layers past each other when the rocks were tilted and bent to form the Nittany Mountain anticline, approximately 250 million years ago. The pit lays open 150 feet of section, with the uppermost beds occurring approximately 350 feet below the top of the Rose Hill Formation.

The Rose Hill shales at Nittany Mountain Campground contain a profusion of marine invertebrate and trace fossils. Most abundant are small, distinctly lobed, zygobolbid ostracodes (especially *Bonnemaia* sp.) and tiny, needle-shaped and ribbed cricoconarids (*Tentaculites minutus*), both of which are clearly visible under a 10X hand lens. More readily discerned by the unaided eye are the numerous coelospirid brachiopods (*Eocoelia* sp.) and phacopid trilobites (*Liocalymene clintoni*) and the less common bivalves (*Nuculoidea* sp.) and strophodontid brachiopods (*Brachyprion* sp.). These invertebrate

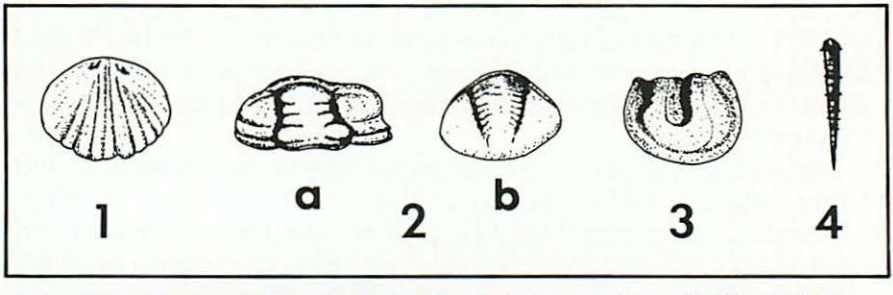

Figure 2. Common fossils from Rose Hill Formation at Nittany Mountain Campground. 1 = *Eocoelia* sp., X1.3; 2 = *Liocalymene clintoni* (Vanuxem), X1.2, a. cephalon, b. pygidium; 3 = *Bonnemaia* sp., X5; 4 = *Tentaculites minutus* (Hall), X4.

fossils, a few of which are illustrated in Figure 2, occur primarily as internal and external molds in the clay shales. Also prominent at several horizons in the pit is the horizontal trace fossil *Chondrites,* believed to represent the regularly branching feeding tunnels of a marine worm.

Nearly all of the invertebrate shells show complete or partial replacement of the original calcitic or aragonitic shell substance by a mixture of milky quartz and sparkly green chlorite. X-ray diffraction analysis indicates that the chlorite is a relatively iron-rich variety, probably 14A chamosite, according to the classification of Bayliss (1975) (R. C. Smith, II, and John H. Barnes, personal communication). The chlorite typically occurs as tiny (0.1 mm or less) flakes forming a reticulate mesh normal to the original shell surface, whereas the quartz is in subhedral crystals up to 0.5 mm in length that appear to post-date the chlorite mesh. Some of the quartz crystals have sharp, pyramidal terminations. In leached and weathered shale, chlorite weathers to reddish-orange iron-oxide which stains the surfaces of the fossil molds. Although many ostracode and cricoconarid shells are completely replaced by the quartz-chlorite mixture, it appears that most of the larger fossils—the brachiopods and trilobites, for example—are only partially replaced.

The yellowish-gray Rose Hill clay shales at the Nittany Mountain Campground pit originated from argillaceous sediments that accumulated in the quiet, moderately deep, rather poorly oxygenated (dysaerobic) marine shelf waters which existed here about 425 million years ago (Cotter, 1983). When first deposited, the sediments probably consisted of a complex suite of clay minerals—i.e. illite, kaolinite, smectite, chlorite, etc.—together with abundant silt-and-clay-size quartz. Slow and progressive alteration of the initial clay-mineral suite as a result of ion-exhange, dewatering, and increased heat and pressure during burial eventually produced a lithified clay shale composed almost entirely of illite, chlorite, and quartz (see Grim, 1968; Hunter, 1970; and O'Neill and Barnes, 1981). Chlorite-quartz replacement of the invertebrate shell material could have taken place at almost any time that formation waters were mildly reducing and nearly neutral (Krumbein and Garrells, 1952). Laughrey (1984) notes that authigenic, iron-rich chlorite formed during early stages of diagenesis in some Medina (Lower Silurian) sandstones of northwestern Pennsylvania. It is possible that the chlorite-quartz replacement found at Nittany Mountain Campground also occurred relatively early, prior to lithification, when iron-rich pore water was being expelled through burial compaction.

The author thanks Robert C. Smith, John H. Barnes, and Leslie T. Chubb for performing the X-ray diffraction analysis and Donald M. Hoskins for assisting in identification of the ostracodes.

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Mrs. Donna Snyder, Manager of the Pennsylvania Survey's Water Well Licensing and Data Program, on the occasion of her 20th anniversary with the Survey.

HISTORICAL MARKER COMMEMORATES EARLY SALT WELL IN CRAWFORD COUNTY

by John A. Harper

On May 17, 1985, the Pennsylvania Historical and Museum Commission unveiled a new historical marker at the side of state route 198 in Beaver Township, Crawford County, about 5½ miles west of Conneautville. The marker (Figure 1) commemorates the drilling of what appears to be the earliest salt-producing well in northwestern Pennsylvania, commenced in 1815. As something of an added attraction, the well also became a milestone in the history of the state's oil and gas industry. But this is not surprising—salt and petroleum production have had a very close relationship for over 200 years.

Oil and gas are certainly not new commodities in Pennsylvania. As early as 1748 the American travelogue of Peter Kalm, a former pupil of Linneaus, cited the occurrence of oil springs along Oil Creek in what is now Crawford and Venango Counties (Owen, 1975). The excellent "Map of the Middle British Colonies in America," an early mapping event in colonial America by Lewis Evans, showed the locations of these springs (Lytle, 1959). The springs were exploited by the American Indians, and later by the European settlers moving into or through the region, basically for medicinal purposes; the naturally occurring crude was purported to be a purgative and an effective treatment for rheumatism. Natural gas was recognized early for its value as a fuel ("illuminating gas), but it wasn't until the mid-1800's that oil became generally useful as a lubricant and for fuel.

The salt industry was very important in the history of oil and gas production. Techniques such as cable-tool drilling were developed by salt- industry personnel to meet growing market needs, and early salt-well drilling soon disclosed the association of crude oil and natural gas with brine water. The great "burning spring" near present-day Charleston, West Virginia, a salt well that caught fire, was considered a world wonder by Thomas Jefferson and George Washington. Several of the salt works at Tarentum in Allegheny County provided enough crude oil along with the brine waters to help establish a small petroleum refining industry in Pittsburgh. While observing the salt-drilling industry at Tarentum in Allegheny County, "Colonel" Edwin Drake learned the best method of drilling his now-famous well at Titusville.

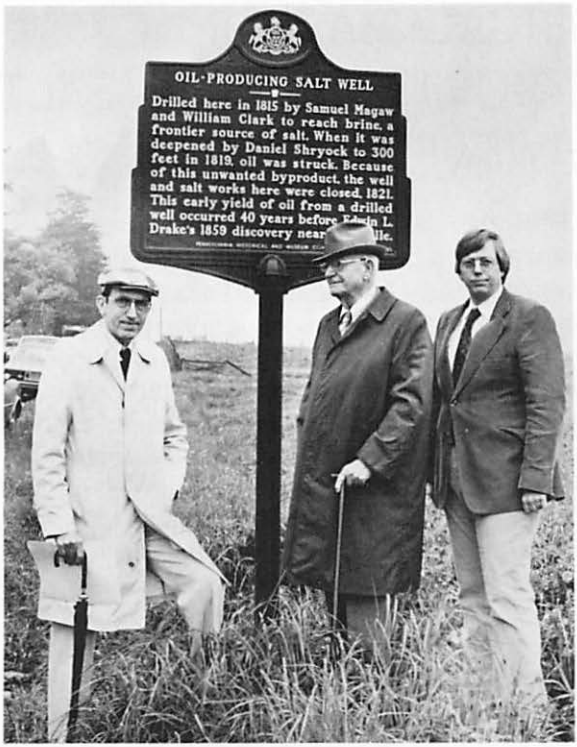

Figure 1. Historical marker dedicated May 17, 1985 in Crawford County. Participants include (from left) Samuel T. Pees, who found the well, Walter Small, the last surviving founding member of the American Association of Petroleum Geologists, and John Harper. (Photo courtesy of Jorge Valdes, Samuel T. Pees and Associates.)

The salt industry was more important to early western Pennsylvania history than was oil and gas, however. With the American Revolutionary War, and the western expansion of the American settlements, came a need for cheaper means of obtaining salt than transporting it across country from Salina, New York. The growth of Pittsburgh from a military fortress to an industrial city created a major market for salt. The salt-trade routes from Salina crossed New York to Buffalo, across Lake Erie to Erie, Pennsylvania, from Erie to Waterford in Erie County, then down through northwestern Pennsylvania by way of French Creek to the Allegheny River (Pees, 1983). When salt was subsequently discovered in areas surrounding Pitts-

burgh, particularly at Tarentum and Saltsburg, the market for Salina salt decreased, as did the trade along the old routes. This lack of salt trade in and across northwestern Pennsylvania prompted the communities to develop their own sources of salt, and several drilling operations in the early 1800's. The following is excerpted from a recent publication by Pees (1983, p. 107):

> In 1815, Samuel B. Magaw and Judge William Clark of Meadville undertook the drilling of a salt well in southwestern Beaver Township (Allegheny Magazine, 1817). The well was located near what was later to be called Reed's Corners...the well had found salt water and was then at a depth of 186 feet. Thirty kettles for boiling the brine were put into operation. The yield was ten bushels of salt per day. Mr. Magaw died in 1816 and Mr. Daniel Shryock of Meadville entered the business and became the principal operator.
>
> In 1816, the well was deepened to 270 feet in the belief that the formation water would be more salty at depth...Plans to further deepen the well were put into effect. Either in later 1818 or in 1819, the well depth was reported to be 300 feet (History of Crawford County, 1885, p. 264). While the final total depth of the well is uncertain, at some point in drilling, presumably deeper than 270 feet, oil was struck in sufficient quantity to cause serious contamination of the brine. Due to the oil, the salt works foundered and were finally abandoned in 1821.

The oil in the Reed's Corners well presumably came from the "Venango Third sand" (Upper Devonian, Venango Group), one of the principal oil reservoirs of northwestern Pennsylvania. Oil from this reservoir has been produced in commercial quantities as far west as Vernon Township, Crawford County (Lytle and others, 1976). The Reed's Corner well was, unfortunately for the operators, ahead of its time. Salt was selling for about $11 per 5 bushels (Pees, 1983), making the daily production of the well worth about $22. Crude oil, on the other hand, was considered a nuisance at that time. Had the well been drilled 20 years later, the owners would have been able to sell the oil; 40 years later they may have made a fortune.

The Reed's Corner salt well was again located in 1982 by the diligent field work of Sam Pees of Samuel T. Pees and Associates, Meadville. The well is situated on the Edgar T. Miller farm, in a small tributary of Middle Branch Creek (Figure 2), a part of Conneaut Creek drainage system. The 3-foot diameter wooden conductor pipe is visible under the water, but no other sign of the old salt works is apparent. Although the hole was plugged, the farmer constructed a wooden fence around the site to keep his cows from getting stuck in the mud at the surface (Figure 3).

The Crawford County historical marker is the second of geological interest to be unveiled by the Pennsylvania Historical and Museum

Figure 2. The well head is under water, but the 1983 photo shows the three-foot diameter wood conductor pipe (surrounding the darker circle of the well hole on the creek bottom) (from Pees, 1983).

Figure 3. A later (1984) photo of the well site shows the fencing erected by the farmer, Mr. Edgar T. Miller, to keep his cattle from stumbling into the open hole. (Photo courtesy of Jorge Valdes, Samuel T. Pees and Associates.)

Commission in as many months. The first marker, concerning the Pittsburgh coal seam, was unveiled in Pittsburgh on April 18. This is encouraging for geological historians who feel that historical markers commemorating important geological features and events in Pennsylvania have been sorely lacking. It is to be hoped that these two markers represent only a first step in rectifying a troubling oversite.

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WHEN MEXICO SHOOK, PENNSYLVANIA JUMPED

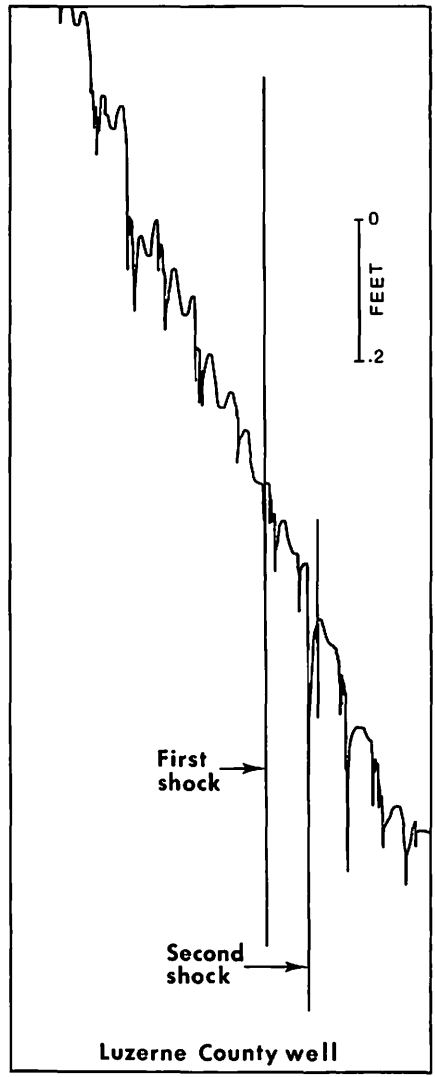
A September 19th survey of continuous water level records on 24 observation wells in the Susquehanna River Basin revealed that in 12 of those Pennsylvania water wells the earthquake shocks are clearly identified by sudden, short jumps in the water level. Those jumps are clearly shown on the water level recording tapes which are operating at each observation well; two of those tapes have been reproduced here on the accompanying figures. On each tape there is a sharp jump for both the first and second major earthquake shocks in Mexico, spaced about a day apart.

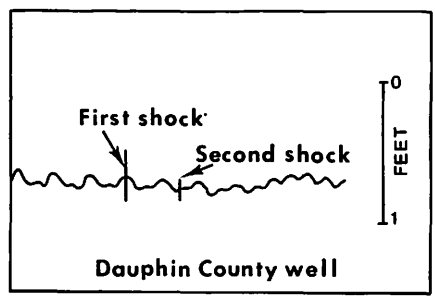
The following table of observation wells shows the extent of the quake related water level jump in each well:

County	*Well Number*	*Jumps*
Adams	AD-146	.05 ft.
Centre	CE-118	.69
Clinton	CN-1	.06
Dauphin	DA-350	.35
Franklin	FR-332	.3
Fulton	FU-93	.2
Huntingdon	HU-301	.16
Juniata	JU-351	.4
Luzerne	LU-243	1.22
Snyder	SN-130	.05
Susquehanna	SQ-61	small
York	YO-180	.1

To understand the basis of the water level jump, consider a drinking straw half filled with water. If you pinch the lower half containing the water, the water level in the straw will rise while pinched. Similarly, when the earthquake occurred, the rocks surrounding each of the water wells were momentarily expanded, which in effect "pinched" the well hole causing the water in the well to rise momentarily. This is not a new or unknown phenomenon; we observed the same thing when the big Alaskan earthquake took place in 1964 near Anchorage.

The observation well-program is a continuing one in Pennsylvania consisting of 65 wells and co-sponsored by the Water Resources Division of the U.S. Geological Survey and by DER's Bureau of Topographic and Geologic Survey. The wells are serviced and monitored by the U.S. Geological Survey, which also retains the water level records for each well since its installation. Such records provide a basis for long range evaluation of water level conditions throughout the Commonwealth.





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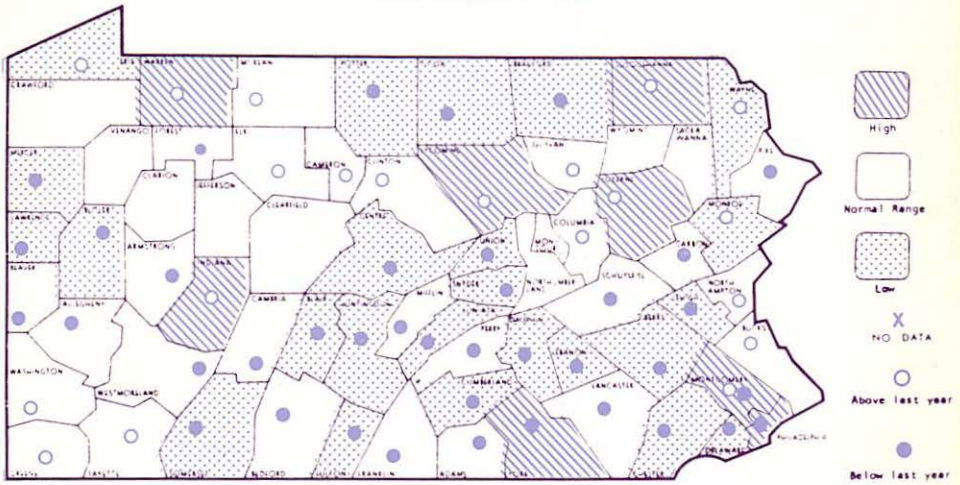

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