SUMMER 1990

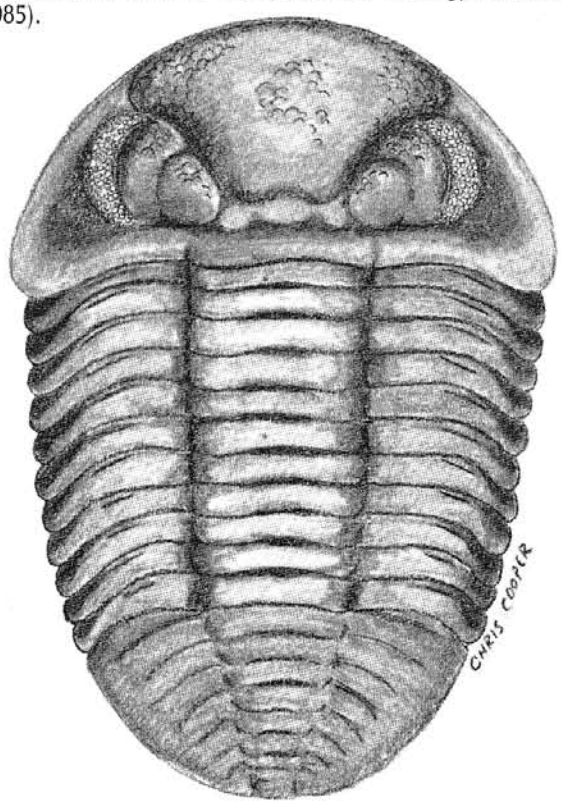
Ohio Geology Newsletter

Division of Geological Survey

COMMON TRILOBITES OF OHIO

by Douglas L. Shrake

Many people have an aversion to "bugs" and other crawly critters, but when it comes to fossils an extinct "bug," known as a trilobite, is among the most highly prized specimens. Indeed, there is such a fascination with trilobites that one, *Isotelus*, was named the official state fossil of Ohio in 1985 (see *Ohio Geology*, Summer 1985).

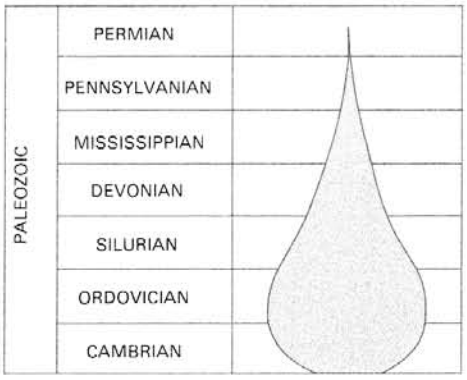


Phacops rana. *This trilobite, probably the most well-known Ohio species, is common in the Silica Formation (Middle Devonian) in northwestern Ohio. Illustration by Chris Cooper.*

Of the six geologic systems exposed in Ohio, trilobites have been found in all but Permian-age rocks. Although a few trilobite species survived until the middle of the Permian, when they finally became extinct, none are known from Ohio because by Permian time the sea in which the trilobites lived had completely withdrawn from the area that is now Ohio.

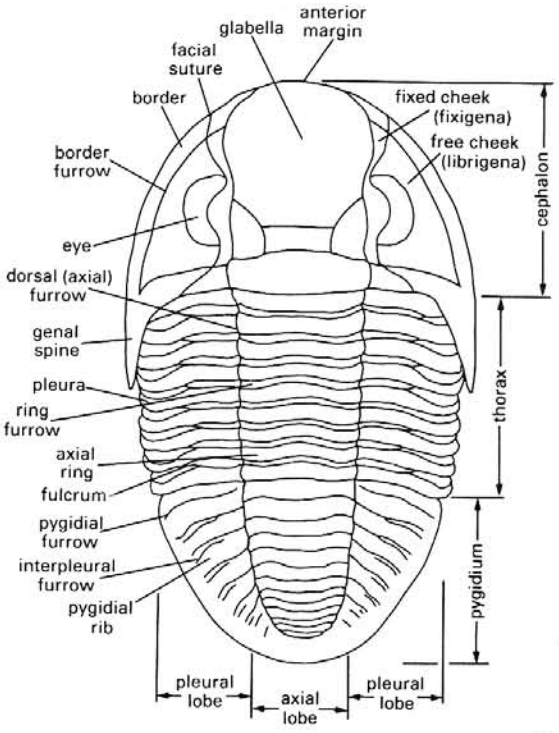
Trilobites belong to a class of animals known as Trilobita, a subdivision of the great phylum Arthropoda, which includes insects, crabs, lobsters, scorpions, centipedes, and spiders, among others. The name of this class of animals is derived from the three-lobed longitudinal division of the body. The accompanying diagram illustrates the general morphological features common to many trilobites.

Trilobites were entirely marine, that is, they lived



Abundance of trilobites during the Paleozoic Era.

exclusively in the sea, from their first appearance at the beginning of the Cambrian Period (570 million years ago) to the middle of the Permian Period (260 million years ago). The majority of trilobites crawled on or burrowed through soft, muddy seafloor sediments and obtained nutrients by ingesting mud, somewhat like an earthworm. They are thought to have hatched from eggs, as this is the reproductive method employed by all living arthropods.



Generalized morphological features of Ditomopyge, *a Pennsylvanian trilobite (from Division of Geological Survey Report of Investigations No. 142).*

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ODNR
OHIO DEPARTMENT OF NATURAL RESOURCES

Richard F. Celeste, Governor • Joseph J. Sommer, Director

FROM THE STATE GEOLOGIST . . . by Thomas M. Berg

NATIONAL ENERGY STRATEGY AND OHIO'S OIL AND GAS GEOLOGY

Iraq's August 1990 invasion of Kuwait rightly revives public concern about the chances for world peace. It also revives public apprehension about fuel prices and dependency upon foreign imports. In the 1970's, crises in the Middle East caused the price of oil to rise to over $35 per barrel. We became "energy conscious" and the words "energy crisis" fell from our mouths as we sat in the gasoline lines and griped about skyrocketing prices. During the 1970's, oil drilling activity increased. But during the 1980's the price of oil declined, and oil and gas producers in the United States faced severe difficulty. It was especially difficult for the independents such as those in Ohio who regularly take the big risk of drilling for deeper, more complex, and less understood hydrocarbon targets.

It is time for our government policymakers to aggressively confront the obstacles to development of our domestic hydrocarbon resources. We need a national energy strategy that vigorously promotes exploration for U.S. oil and gas. We need a strategy that reconsiders existing tax policies and allows financial incentives for exploration and production. The image of the wealthy, comfortable oil and gas producer is far from accurate. A more precise image is of a person who is willing to take big risks, and, as often as not, comes out on the losing end. We need a national energy strategy that significantly expands research on oil and gas, assisting the independent producers in locating and developing the remaining reservoirs which are hidden in extremely subtle stratigraphic and structural settings. Most assuredly, a strategy must give "equal time" to the need for research on the oil and gas geology of the northeastern and midwestern states compared with the southwestern and Gulf Coast states. We need a strategy that revitalizes national concern about energy conservation. A strategy should assure a reasonable balance between protection of the environment and freedom to develop our natural hydrocarbon resources. There are international issues that a national energy strategy must address—obviously including controls on hydrocarbon imports. The United States has only 4 percent of the world's proven oil reserves, but has larger reserves of coal than any other nation. I believe we need a national energy strategy that rapidly reduces our dependency on foreign hydrocarbon imports, enlarges our capability of utilizing our rich coal deposits, and recognizes the importance of domestic oil and gas as a critical bridge to the time of full coal utilization.

The Ohio Division of Geological Survey is most anxious to participate in the development of the state's hydrocarbon resources. Our fundamental mission as a state geological survey is to develop and document the geologic framework of Ohio. We have a Section in the Division called *Subsurface Stratigraphy and Petroleum Geology* that has the goal of developing and documenting the geologic framework of the state that is below the surface and accessible only through drilling or geophysical technologies. Under the direction of Ronald G. Rea, the staff of the Subsurface Stratigraphy and Petroleum Geology Section build and maintain the only statewide center for subsurface-geology records. The files which are open to the public include drilling records (approximately 250,000), geophysical logs (approximately 54,000 suites), and township maps (approximately 1,100) showing the location of all known drill-hole sites. In addition to these records, the Section holds thousands of other records from various sources. The Section also maintains a subsurface-sample library that has over 215,000 feet of core, and cuttings from approximately 4,200 oil and gas wells. With funding appropriated by the Legislature, the Section is in the process of building a geographic information system (GIS) to manage all subsurface geologic information. When fully operational, this computer system will be able to carry out data-retrieval, data-management, and data-compilation tasks in minutes that used to take days or months to do by hand. This computerization effort is being carried out in cooperation with the Division of Oil and Gas.

In addition to building and maintaining the only statewide oil and gas database, the Subsurface Stratigraphy and Petroleum Geology Section is carrying out geologic research and subsurface mapping that will greatly assist in the development of Ohio's oil and gas resources. With funding from the U.S. Department of Energy, the Section is investigating the geology of the Cambrian-Ordovician Rose Run sandstone, a very important hydrocarbon target in the state. With support from several companies, the Ohio Survey has entered into a consortium with the Indiana and Kentucky Geological Surveys to investigate the newly discovered Precambrian (?Eocambrian) basin complex beneath the Cincinnati Arch.

The Ohio Geological Survey is the only agency that can accomplish the statewide record-keeping and the necessary statewide subsurface research needed to develop our oil and gas resources. Individually, independent producers cannot develop the massive database and conduct the basinwide research they need to be able to make the tough, high-risk decisions that precede drilling and production. The perilous situation in the Middle East spurs the Survey to greater determination to assist in the development of our domestic reserves.

OHIO GEOLOGY

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News items, notices of meetings, etc. should be addressed to the attention of the editor. Change of address and new subscriptions should be addressed to the attention of the secretary.

GEOLOGICAL CONSULTANTS LIST

In order to better assist the public, the Survey is compiling a computerized list of consultants in Ohio geology. The list will be provided on request to any citizen; however, listing of a consultant does not constitute an endorsement by the Survey. Consultants wishing to be on the list should provide their name, address, telephone number, and areas of expertise to either Patty Nicklaus or Mark Baranoski, Subsurface Stratigraphy and Petroleum Geology Section, Division of Geological Survey, 4383 Fountain Square Drive, Columbus, OH 43224-1362 (telephone 614-265-6585).

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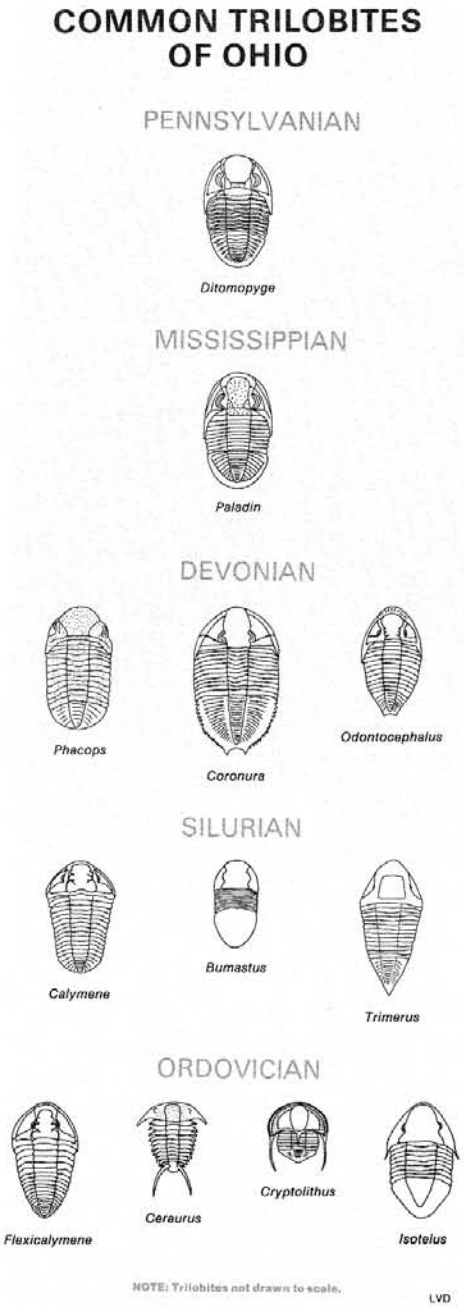
Also like living arthropods, trilobites grew by molting (shedding) the hard outer body covering known as the exoskeleton. Fragments of shed exoskeletons of trilobites are common fossils. Indeed, most specimens are fragmentary. Less commonly, trilobites are found as complete specimens that are either outstretched (prone) or enrolled. It is thought that trilobites enrolled for protection, much like the method employed by modern pill bugs.

The following paragraphs discuss some of the common trilobites found in Ohio rocks. The term common, however, should not be confused with "easy to find." In this discussion, "common" refers to the fact that if one finds a trilobite in Ohio it is likely to be one of the species discussed below.



ORDOVICIAN

Trilobites are more diverse and abundant in Ordovician rocks in Ohio than in any other geologic system. The tristate area of north-central Kentucky, southeastern Indiana, and southwestern Ohio is world renowned for abundant and well-preserved trilobites and other fossils. Although trilobites can be found in both limestone and shale in this region, it is the shale beds that have produced the greatest number of specimens. One particular bed in Warren County is known informally as the "trilobite shale."

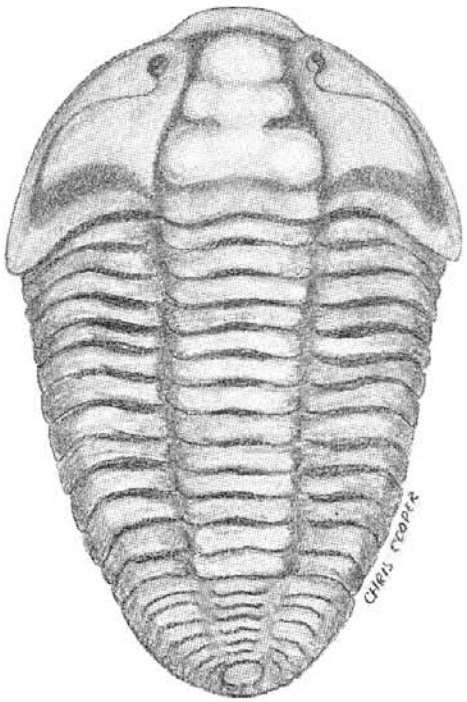
At least 20 species of trilobites are known from Ordovician rocks of Ohio.

Fossil hunting in Ordovician rocks at Caesar Creek State Park. These rocks are noted for trilobites.

Perhaps the most common and readily recognized Ordovician trilobite is *Flexicalymene*. The species in this genus are differentiated by the following characteristics.

- *Flexicalymene meeki* has a semitriangular cephalon with prominent but short genal spines and an exoskeleton covered with fine granules. This species reached a maximum size of about 2¼ inches.
- *Flexicalymene retrorsa* differs from *F. meeki* by having a more semicircular cephalon with rounded genal angles and a more steeply and vertically inclined anterior border. This species reached a length of about 1¾ inches.
- *Flexicalymene granulosa* differs from the other two species by having a more coarsely granular surface texture. This species reached a maximum length of about 1½ inches.

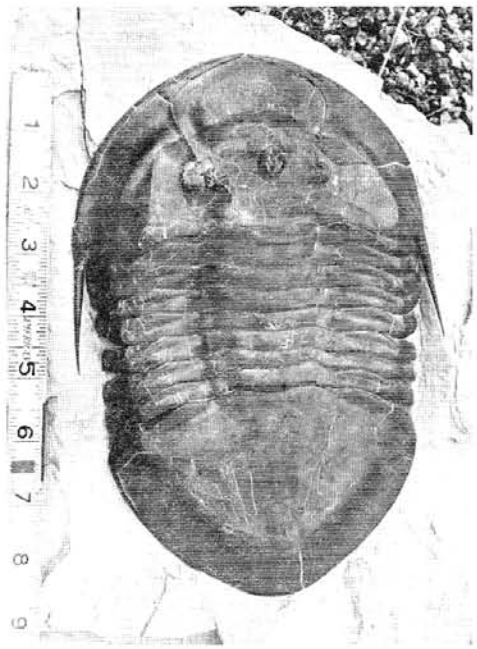
Isotelus is a common fossil in Ordovician rocks in the Cincinnati area; however, most specimens are fragmentary and complete specimens are rare. Enrolled specimens can be collected after they have weathered out of a shale bed, but prone specimens are generally collected from excavations in fresh, unweathered shale. Prone specimens are rare because the shale holding the trilobite together quickly weathers when exposed to the elements, causing the specimen to disintegrate. Fragments and complete specimens also can be found in limestone beds.



Flexicalymene retrorsa. *This trilobite is comparatively abundant in Ordovician rocks in southwestern Ohio. Illustration by Chris Cooper.*

Three species of *Isotelus* are currently recognized in Ordovician rocks in Ohio. However, two species, *I. brachycephalus* and *I. maximus*, may prove to be the same species when they are more thoroughly studied. All species of *Isotelus* are characterized by a low, flat profile, smooth cephalon and pygidium, eight thoracic segments, and a broad axial lobe.

- *Isotelus maximus* has a cephalon and pygidium that are more elongated (parabolic) than the other two species. The genal spines are long and commonly curved. This species is estimated to have grown to more than 18 inches in length.
- *Isotelus brachycephalus* is known from only five complete specimens, including the famous Huffman Dam specimen which now resides in the Smithsonian Institution (see *Ohio Geology*, Summer 1985). This species differs from *I. maximus* in that it has a much broader, semi-elliptical cephalon and pygidium. The genal spines extend as far back as the fourth thoracic segment. This species is estimated to have reached lengths of



Isotelus maximus. *This Ordovician trilobite is among the largest known and was named the state fossil of Ohio in 1985.*

more than 18 inches.

- *Isotelus gigas* has a triangular-shaped cephalon and pygidium, with genal areas that are commonly rounded or have very short, pointed spines. The width and length of specimens are nearly equal, giving them a unique oval outline. This species reached lengths of slightly greater than 8 inches.

Cryptolithus has been collected primarily from the oldest Ordovican rocks exposed in the Cincinnati area. Although only a few complete specimens of this trilobite are known, fragments of its distinctive cephalon border are common. Only one species, *C. tessellatus,* has been reported from Ohio. *Cryptolithus* has been nicknamed the "lace collar" trilobite because of its heavily pitted and ribbed border. This species attained a body length of only about ¾ inch.

Ceraurus occurs in the older Ordovican strata in the Cincinnati area. Only one species, *C. milleranus,* is known in Ohio. It is readily identified by its winglike cephalon and the pair of long spines projecting from its small, triangular pygidium. *Ceraurus* reached lengths of about 2 inches.

SILURIAN

Silurian rocks of Ohio have produced several trilobite genera. However, unlike the well-preserved Ordovician trilobites found in the state, most Silurian specimens are preserved as casts or molds in limestones and dolomites exposed in western Ohio. Although trilobites had begun to decline in numbers by the Silurian Period, their diversity still remained large.

Calymene is similar in appearance to *Flexicalymene* of Ordovician age but possesses a more semicircular cephalon with very rounded genal angles. *Calymene's* thorax tapers to a small, semicircular pygidium, in contrast to the triangular-shaped pygidium of *Flexicalymene.* The glabella of this genus has a more blunt termination at the anterior border than does the glabella of *Flexicalymene. Calymene* attained lengths of about 1⅛ inches. *C. niagarensis* is the most common species found in Ohio.

Trimerus is characterized by its triangular cephalon, rectangular glabella, and triangular pygidium that has a small terminal spine. *Trimerus* has a very indistinct axial lobe and reached lengths of 1¾ inches. One of the more common species, *T. delphinocephalus,* is particularly abundant in Silurian rocks in south-central Ohio.

Bumastus has a smooth cephalon and pygidium similar to that of *Isotelus;* however, it has a more inflated (thicker) profile than does *Isotelus.* The axial lobe of *Bumastus* is almost nonexistent along the thorax. An unusual aspect of this trilobite is that its maximum length of 1½ inches is almost equal to its maximum width of 1 inch, thus giving it a nearly oval outline. *Bumastus niagarensis* is the most common species of this genus in Ohio.

DEVONIAN

Devonian rocks of Ohio are famous for producing abundant and well-preserved trilobites. The most well-known Devonian trilobite, and perhaps the most well-known Ohio trilobite, is *Phacops rana.* Specimens of this species were collected by the thousands from a quarry near Sylvania, west of Toledo. *Phacops* is the only Devonian trilobite known from Ohio that does not have either genal or pygidial spines. These trilobites are characterized by their inflated glabella and large, froglike eyes, hence the specific name of *rana,* Latin for frog. Both the cephalon and pygidium are semicircular, and the glabellar surface is covered by numerous coarse bumps. Most specimens are less than 2 inches in length, although some specimens exceed this size.

Almost all Ohio specimens of *Phacops rana* have been collected from shales of the Silica Formation, of Middle Devonian age. This unit is present only in northwestern Ohio, on the flank of the Michigan Basin, and is exposed primarily in a few limestone quarries. The most famous locality for *Phacops* was the Medusa Portland Cement Co. quarry near Sylvania, which for many years was open to collectors on weekends and produced many thousands of exquisitely preserved prone and enrolled specimens (see accompanying article, New Deal trilobites). This quarry is now inactive and without exception closed to fossil collecting.

Coronura is the largest Devonian trilobite found in Ohio, reaching lengths in excess of 8 inches. The cephalon has large eyes and genal spines. The border of the pygidium has numerous pleural spines. *Coronura* is found primarily in the Columbus Limestone, of Middle Devonian age.

Odontocephalus has a distinctive cephalon with a series of oval perforations along the anterior margin and long genal spines. The pygidium lacks the numerous pleural spines of *Coronura,* but does have two spines near the terminus of the pygidium. *Odontocephalus* is known from the Columbus Limestone; specimens commonly exceed 2 inches in length.

MISSISSIPPIAN

The Mississippian Period in Ohio was marked by a change in the type of sediment being deposited in the sea that covered the area that is now Ohio as sand and mud were carried westward by streams. The muddy Mississippian sea apparently was not particularly suitable for trilobites, as only three trilobite genera are known from Mississippian rocks in Ohio—*Paladin, Australosutura,* and *Proetus*—and only *Paladin* can be considered common.

Paladin has a semicircular cephalon with prominent medium-sized eyes and stout genal spines which extend to the fifth thoracic segment. The surface of the entire exoskeleton has a fine, granular texture. The axial and pleural lobes of the thorax are nearly equal in width, and the pygidium is large and semicircular with a pronounced border flange. *Paladin* reached a length of 1¼ inches.

PENNSYLVANIAN

By Pennsylvanian time the great coal-swamp deltas, formed from sediment eroded from the rising Appalachian Mountains, had nearly excluded the sea from Ohio. Thin beds of marine limestone and shale represent brief incursions of the sea over the coal-swamp deltas. Although Pennsylvanian trilobites are decidedly rare and diminuitive, three genera—*Ditomopyge, Sevillia,* and *Ameura*—are known from Ohio. The most common genus is *Ditomopyge.*

Ditomopyge has a semicircular to parabolic cephalon and pygidium. The glabellar region is covered by fine to coarse granules. The cephalon has stout genal

spines and large crescent-shaped eyes. The thorax is composed of nine nonuniform segments. The pygidium is distinct from the thorax and has a moderately wide border flange. Two species of *Ditomopyge, D. scitula* and *D. decurtata,* are known from Pennsylvanian rocks in Ohio. *Ditomopyge decurtata* differs from *D. scitula* by the lack of strong anterior inflation of the glabella and a smoother, less furrowed pygidium. Each of these species can reach a length of 1¼ inches.

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RALPH BERNHAGEN HONORED

Ralph J. Bernhagen (center) receiving AASG certificate from State Geologist Thomas M. Berg (right) and ODNR Director Joseph J. Sommer (left).

Former State Geologist of Ohio (1957-1968) Ralph J. Bernhagen was elected to honorary membership in the Association of American State Geologists at the annual meeting of this organization in Madison, Wisconsin, on June 10-13. AASG is an organization composed of the current State Geologists from each state.

Bernhagen received this honor because of the active role he played in AASG while serving as State Geologist of Ohio. The honorary membership certificate was presented to him by State Geologist Thomas M. Berg and Joseph J. Sommer, Director of the Ohio Department of Natural Resources, at a meeting of the Division of Geological Survey staff in July.

BERG APPOINTED TO AASG COMMITTEES

State Geologist Thomas M. Berg was appointed to the Association of American State Geologists Committee on Energy Policy and to the North American Commission on Stratigraphic Nomenclature at the annual AASG meeting, held in Madison, Wisconsin, on June 10-13. Berg and Division Assistant Chief Robert G. Van Horn also serve on AASG's Committee on Digital Cartography Standards and Protocol.

NEW DEAL TRILOBITES

Trilobites have long been of interest to at least some segments of Ohio society, as evidenced by the naming of an Ordovician trilobite, *Isotelus,* as Ohio's official state fossil in 1985 (see *Ohio Geology,* Summer 1985). However, a Devonian trilobite from Ohio, *Phacops rana,* is perhaps even better known than *Isotelus* and provided the basis for one of the more interesting and unique works of art to be created during President Franklin D. Roosevelt's Depression-era New Deal programs.

This art work, shown in the accompanying illustration, was done in 1940 by New York City-based Romanian sculptor Melik Finkle for the U.S. Post Office in the Lucas County town of Sylvania. The sculpture, a plaster bas relief showing two individuals inspecting specimens of *Phacops rana,* was featured in an article by Gerald Markowitz and Marlene Park entitled "Not by bread alone: post office art of the New Deal," in the June-July 1989 issue of the Ohio Historical Society magazine *Timeline.*

As Markowitz and Park note in their article, the Sylvania post office sculpture was one of 1,400 murals and sculptures done by 850 artists for 1,100 post offices throughout the country. Sixty-six Ohio post offices received such works of art.

This ambitious project was part of Roosevelt's New Deal during the Great Depression, a program that created jobs for out-of-work Americans on public projects. Most of the New Deal jobs were for laborers on various road and civic projects, but writers and artists were included in the efforts at economic recovery. Markowitz and Park quote Harry Hopkins, Roosevelt's administrator of the emergency relief program, in his defense of public jobs for artists, as saying, "Hell! They've got to eat just like other people."

The trilobites that Finkle immortalized in his sculpture have, for many years, been a sort of "claim to fame" for Sylvania. A nearby quarry, first opened by the Sandusky Cement Company in the 1920's, exposed a thin, bluish-gray shale, part of the Silica Formation, that contained an assemblage of exquisitely preserved fossils, including abundant specimens of *Phacops rana.* Dr. Grace Anne Stewart, an instructor of geology at The Ohio State University, described the fossils of the Silica shale in a 1927 Survey bulletin. She listed 63 fossil species, many of which have been of considerable interest to paleontologists throughout the years. However, to rockhounds and fossil collectors, the Silica shale produced only one species of note, *Phacops rana* trilobites.

Most specimens of *Phacops* do not exceed a couple of inches in length and many are found in an enrolled position, a defensive posture that these bottom-dwelling mud eaters used to ward off predators. They are perhaps best characterized by their large, froglike eyes, each of which is made up of dozens of individual lenses—the typical compound eye of arthropods. Finkle, obviously a more accomplished sculptor than paleontologist, noted that the quarries near Sylvania contained a variety of fossils including "froglike reptiles." As it would be another 50 million years before vertebrates would emerge onto land and another 80 million years or so before reptiles appeared, Finkle was obviously mistaken in his fossil-identification attempts. Perhaps he was referring to the froglike appearance of the head of *Phacops.*

Thousands of specimens of *Phacops rana* from this quarry (later owned by the Medusa Portland Cement Company and today by the France Stone Company) found their way into fossil collections throughout the world. Indeed, collectors came to the quarry near Sylvania not only from Ohio but from throughout the United States. During the heyday of its operations, the quarry became host to hundreds of weekends fossil collectors, most of whom were in search of perfect

Trilobites, *by Melik Finkle. Plaster relief, 2½ x 4¼ feet, 1940. This sculpture in the Sylvania, Ohio, post office commemorates a Devonian trilobite,* Phacops rana, *and the importance of the rich paleontological heritage to this community near Toledo. Photo by Connie Girard, courtesy of the Ohio Historical Society.*

specimens of *Phacops rana.*

The quarry has been inactive for a number of years and is totally closed to collecting. The Survey still receives, as does the France Stone Company, numerous inquiries from throughout the country from individuals seeking information on gaining access to this legendary trilobite burial ground. Although the inactive quarry is closed to the public because of federal mine-safety regulations and safety concerns, most collectors would probably be greatly disappointed even if they could gain access to the quarry. The Silica shale weathers rapidly, as do the trilobites it contains. A steady production of well-preserved trilobites therefore depends upon an active, ongoing quarry operation at the site.

The Silica Formation is a rock unit of limited distribution that formed in a shallow, tropical Devonian sea on the edge of the Michigan Basin about 380 million years ago. The unit apparently pinches out to the southeast towards a structural feature known as the Findlay Arch. The relatively flat lake plains of northwestern Ohio offer few natural exposures of bedrock, so the Silica Formation has been known primarily from exposures in a few quarries in northwestern Ohio and southern Michigan. None of these exposures have gained the popular reputation, however, that has accrued to the famous quarry at Sylvania.

Collecting of *Phacops* trilobites will perhaps never again prosper to the extent that it did during the difficult, but in some ways simpler, days of the Great Depression and successive decades. Nevertheless, thousands of specimens of these trilobites in museum and private collections still serve as ambassadors of Ohio's rich paleontological heritage.

ACKNOWLEDGMENTS

We thank Christopher S. Duckworth, editor of *Timeline,* for furnishing us with a copy of Connie Girard's exceptional photograph of Finkle's sculpture in the Sylvania post office. Bruce Mason and Ron Tipton of France Stone Company provided information on quarry history and the Silica shale at Sylvania.

—Michael C. Hansen

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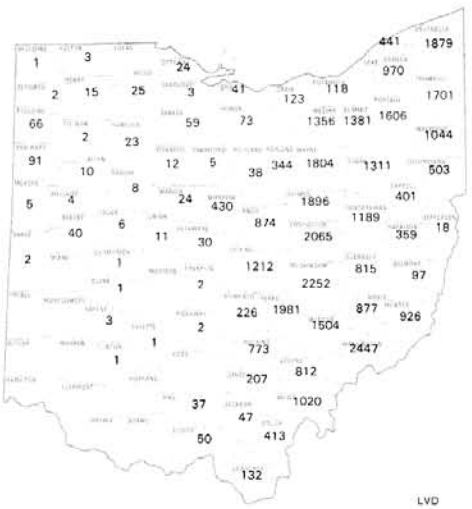
THE 1980'S: BOOM AND BUST IN THE OHIO OIL AND GAS INDUSTRY

by Michael P. McCormac
ODNR, Division of Oil and Gas

Perhaps no other decade typifies the cyclic boom-and-bust nature of the oil and gas industry in Ohio as the 1980's. The 1980's began on a very optimistic note. Oil and gas prices were on the upswing, leading to all-time highs, which encouraged drilling, resulting in a modern-day record of gas production and the highest total oil production since the Morrow County boom in 1965. As a result of the record prices and production, the combined dollar value of oil and gas exceeded $1 billion in 1984 for the first and only time to date. Then came the bust. By the end of the 1980's drilling was a fifth of the decade high, oil prices were down by half, and total dollar value of oil and gas had dropped a third from earlier decade highs.



Cumulative number of wells drilled by county, 1980-1989.

During the 1980's, wells were drilled in 75 of Ohio's 88 counties. The greatest number of wells, 2,447, was drilled in Washington County; five counties had only one well drilled during the period. A total of 38,275 wells were drilled from 1980 to 1989; 35,767 were productive and 2,508 were dry, resulting in a completion rate of 93 percent. The average depth per well was 3,671 feet. Although activity declined in the late 1980's, drilling depths continued to increase, due in part to deeper exploration for oil and gas. The decade-high average of 4,125 feet per well occurred in 1988, closely followed by 4,115 feet per well in 1989.

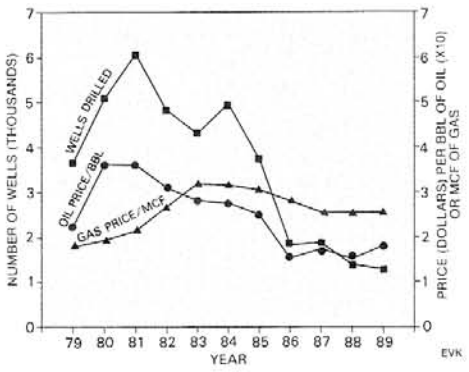
Drilling peaked in 1981 with 6,082 wells, a modern-day record and the seventh greatest total historically. Drilling had dropped to 1,285 wells by 1989. Historical records indicate the all-time record for drilling activity occurred in 1899, when 6,807 wells were drilled, primarily in the Trenton Limestone Lima-Findlay field (northwestern Ohio).

Not surprisingly, this high/low drilling cycle also was reflected in the number of wells drilled in the most active county for each year. In 1981 Washington County was the most active, with 559 wells drilled. In 1988, the most active county was Trumbull County with only 91 wells drilled; for the first time since 1961 the most active county had fewer than 100 wells drilled in a year.

MOST ACTIVE COUNTY FOR DRILLING, 1980-1989

Year	County	Number of wells drilled
1980	Muskingum	366
1981	Washington	559
1982	Wayne	337
1983	Perry	455
1984	Ashtabula	319
1985	Ashtabula	476
1986	Wayne	200
1987	Tuscarawas	122
1988	Trumbull	91
1989	Monroe	117

As expected, the price of oil and gas has a major influence on the amount of drilling activity. This correlation is clearly shown in the accompanying graph—a significant increase in drilling occurred one year after the increase in price. The all-time high price for oil, $36.23 per barrel in 1980, led to the modern-day drilling record (6,082 wells) in 1981. In 1983, gas prices rose to an all-time high of $3.19 per thousand cubic feet (MCF), and correspondingly drilling rose again in 1984. A 19 percent oil-price increase from 1988 to 1989 and stable gas prices from 1987 to 1989 suggest a trend that should encourage additional drilling activity.



Oil and gas prices compared to drilling activity in Ohio, 1979-1989.

Looking at the decade geologically, well completions ranged from shallow Pennsylvanian sandstones to the Cambrian Trempealeau dolomite. There were also several Precambrian test wells drilled. It has been said that the Silurian "Clinton" sandstone is the bread and butter of producers in Ohio—this was overwhelmingly true in the 1980's. The "Clinton" sandstone accounted for over 75 percent of all wells drilled in the 1980's. Following the "Clinton," the Lower Mississippian Berea Sandstone accounted for 12 percent of all drilling. The Berea was consistently the second most actively drilled formation each year with the exception of 1989, when it was third behind the Devonian shales. After an initial flurry of drilling activity in the Devonian shales early in the decade, interest declined, only to pick up again in 1989 due to a high gas-price contract. The Devonian shales accounted for 8 percent of all wells drilled in the decade.

The remaining 5 percent of drilling activity occurred in the following producing zones: Pennsylvanian System, upper Mississippian System, Devonian Oriskany Sandstone, Silurian "Newburg" dolomite, Ordovician Trenton Limestone, Cambrian-Ordovician Rose Run sandstone, and Cambrian Trempealeau dolomite. These last two zones deserve special mention. Although combined they only account for approximately 2 percent of all wells drilled, these two zones account for the majority of exploratory drilling in the 1980's and have the potential to yield a significant amount of production. During the past three years, interest in the Rose Run sandstone has revived; 69 percent (248 of 362 wells) of the Rose Run wells drilled in the 1980's were drilled from 1987 to 1989. Though drilling levels are far below that of the boom days, the Trempealeau zone continues to attract attention, averaging 50 to 60 wells per year.

What does the future hold for the 1990's? It is hard to believe that the next decade will be as active as the 1980's; however, political instability in the Middle East could result in a long-term elevation of oil prices. Such increases will not only encourage more domestic exploration and drilling but will also encourage implementation of advanced technologies such as enhanced recovery and horizontal drilling.

In addition, there are still geological frontiers to be discovered in Ohio. Interest in and exploration of the Rose Run sandstone should continue as well as the possible exploration of southwestern Ohio.

In May 1989 the Division of Geological Survey completed drilling a core hole begun in October 1987 in Warren County to investigate Paleozoic rocks and, if possible, the Precambrian basement rock. This hole is significant because at the projected depth of 3,500 feet for the Precambrian crystalline basement rock, the bit encountered a previously unknown sandstone. Seismic data verified the presence of a basin and indicated that the formation is approximately 3,500 feet thick at the well site and may thicken eastward to more than 5,000 feet. This newly discovered sandstone has been named the Middle Run Formation. Because of hole conditions, drilling stopped at 5,380 feet without reaching crystalline Precambrian basement rock. More than 1,900 feet of the Middle Run Formation was cored. At this time information on the oil and gas potential of this unit is unknown. Perhaps such deep and poorly known units will be the next frontier in the Ohio oil and gas industry.

HIGHLIGHTS OF THE 1980'S

1980	Record oil price per barrel - $36.23
1981	Record oil total dollar value for production - $489,048,852
1981	Record number of drilling permits issued - 11,352
1983	Record gas price per MCF - $3.19
1984	Record gas production - 186,479,632 MCF
1984	Record gas total value for production - $588,355,065
1984	Record total dollar value for combined oil and gas production - $1,008,403,439

FURTHER READING

The Division of Oil and Gas has published annual statistical reports for 1980 through 1989.

Shrake, D. L., Wolfe, P. J., Richard, B. H., Swinford, E. M., Wickstrom, L. H., Potter, P. E., and Sitler, G. W., in press, Lithologic and geophysical description of a continuously cored hole in Warren County, Ohio, including description of the Middle Run Formation (Precambrian?) and seismic profile across the core site: Ohio Geological Survey Information Circular 56, 11 p., 2 pls.

SURVEY STAFF FIELD TRIPS

As with any job or profession, state geological survey geologists tend to become specialized to the extent that it is sometimes difficult to maintain a broad perspective on their own state's varied geology and mineral resources. In order to keep Ohio Survey geologists abreast of current mineral industry activities and give the nongeologic staff the opportunity to see practical applications of geology, the Division of Geological Survey has begun a

series of quarterly field trips for staff members who wish to participate.

The first staff trip was in November 1989 to the Central Silica Co. sandstone quarry and processing plant at Glass Rock, in Perry County. At this operation the Pennsylvanian-age Massillon sandstone is quarried for use in the manufacture of clear- and colored-glass bottles and as silica flour for use in the ceramics industry.

In February 1990, 27 staff members toured the Southern Ohio Coal Co. coal-preparation plant near Salem Center, in Meigs County. This operation is the largest coal-preparation plant, in terms of raw coal tonnage washed, in North America. The process used at this plant washes the coal to remove pyrite and other mineral matter in order to produce a cleaner burning fuel for generating electricity. In March 1990, six Survey staff members also were able to tour the Southern Ohio Coal Co. underground longwall mine in Meigs and Vinton Counties.

In May 1990, 22 staff members visited Briar Hill Stone Co. at Glenmont, in Holmes County. At this operation the Massillon sandstone is quarried and processed to produce dimension stone for architectural and building purposes.

The most recent trip, in August 1990, was to the private museum of Ken Miller in Shreve, Ohio. Miller has assembled a large and impressive collection of artifacts pertaining to the oil and gas industry, particularly in Ohio.

Survey staff viewing historic equipment used in the oil and gas industry at Ken Miller's museum.

Field trips to other mineral industry operations are in the planning stages. We extend our thanks and appreciation to these mineral industry operations not only for allowing us to view their facilities but also for their warm hospitality.

—Sherry W. Lopez
Mineral Resources and Geochemistry Section

QUARTERLY MINERAL SALES, JANUARY—FEBRUARY—MARCH 1990

compiled by Sherry W. Lopez

Commodity	Tonnage sold this quarter[1]	Number of mines reporting sales[1]	Value of tonnage sold[1] (dollars)
Coal	8,436,916	165	$266,739,187
Limestone/dolomite[2]	5,257,477	88[3]	20,413,751
Sand and gravel[2]	4,678,435	187[3]	15,539,340
Salt	1,356,393	5[4]	19,287,570
Sandstone/conglomerate[2]	167,208	17[3]	3,306,107
Clay[2]	189,847	15[3]	588,062
Shale[2]	235,630	14[3]	379,233
Gypsum[2]	57,656	1	547,732
Peat	25,393	2	108,907

[1]These figures are preliminary and subject to change.
[2]*Tonnage sold* and *Value of tonnage sold* include material used for captive purposes. *Number of mines reporting sales* includes mines producing material for captive use only.
[3]Includes some mines which are producing multiple commodities.
[4]Includes solution mining.

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