

# Ohio Geology

a quarterly publication of the Division of Geological Survey

## THE FIRST OIL WELL

by Michael C. Hansen

Colonel Edwin L. Drake is traditionally recognized as the first person to drill a well specifically for the recovery of petroleum. This momentous event occurred in 1859 at Titusville, Pennsylvania, and not only launched a frenzied search for oil, but also marked the beginnings of our hydrocarbon-dependent society. Within months of Drake's discovery well, the drilling spread to Ohio, but the state's, and perhaps the nation's, first oil well had been drilled 45 years earlier in Noble County in eastern Ohio.

Silas Thorla and Robert McKee were two entrepreneurs who decided that a salt well would be a profitable venture in a region where this preservative, transported by horseback across the Appalachians, brought \$2 per bushel. Thorla and McKee chose a site near a deer lick on a stream known as Salt Run, a tributary of Duck Creek, in Noble County, where the village of Olive would eventually be located (now part of the town of Caldwell). Their well is thought to have been drilled to a depth of about 200 feet, where it struck not only the sought-after brine but also oil and gas.



Depiction of the spring-pole method of drilling used in early to mid 19th century wells bored for salt and later for petroleum. This illustration shows the end of the spring pole firmly anchored. Early descriptions of the method used in the Duck Creek valley indicate that the pole rested in a forked stick and had a counterweight on one end of the pole.

The well was drilled by a method known as the spring pole, in which a stiff sapling, usually a hickory pole 35 or 40 feet in length, was weighted at one end and balanced across a vertical, forked stake, forming a classic lever/fulcrum arrangement. The iron drill bit was suspended from the narrow end of the sapling. A rope with loops was also suspended from the sapling and two or three men would place a foot in the loops and, in unison, push down,

thus dropping the sharpened bit onto the rock at the bottom of the hole. The bore hole was literally "kicked down" by this slow, laborious method.

Initially, a horse-powered pump was used to raise the brine from the well. The salt-laden water was boiled in iron kettles to obtain the precious crystals. A thriving salt works was constructed on the site, and a second, deeper well (reportedly to 475 feet) was drilled near the first one in 1816. The salt works prospered for a number of years, but competition from other salt works eventually lowered the price from about \$2 to about 50 cents per barrel. The salt works was destroyed by fire in 1831.

The first well produced about 1 barrel of oil per week, which was gathered by placing the brine/oil mixture in barrels and allowing the oil to rise to the surface. Then a blanket was soaked in the liquid and the oil wrung out of it. Initially, there was little use for the oil, as it was too smoky and foul-smelling to use as a lamp fuel. According to legend, locals determined that anything so odoriferous



Dennis Hull, Head of the Survey's Regional Geology Section, inspecting the 34-inch sycamore-log casing used on the 1816 salt well drilled by Silas Thorla and Robert McKee at Olive, Noble County. The log is heavily permeated with petroleum.

continued on page 3



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

### A BIG THANK YOU TO OUR READERS—AND A REQUEST

Last year, we conducted a survey to make sure that readers of *Ohio Geology* still wanted to receive our quarterly publication. We also allowed space for comments about the publication. The response has been tremendous. I have been reading the returned cards and have yet to find a negative comment. Overwhelmingly, the comments describe *Ohio Geology* as "outstanding," "excellent," "well done," "fascinating," "most interesting," etc. Most readers said, "Keep up the good work!" Many readers made constructive suggestions, and many asked for more articles on fossils, minerals, environmental geology, hydrogeology, and other geological issues. I was most pleased to learn how many earth science and general science teachers in middle schools, high schools, and colleges use *Ohio Geology* as an important resource for class planning.

The major credit for the outstanding success of our quarterly publication goes to Dr. Michael C. Hansen, Editor of *Ohio Geology*. Production has been a labor of love for Mike, who has served as the publication's editor since its beginning with the Summer issue in 1981. Credit also goes to Merrienne Hackathorn, Ohio Geological Survey Editor, and all the staff of our Technical Publications Section, who make sure that all text

and illustrations are laid out just right. Donna Schrappe works diligently to make sure the mailing database is properly managed.

Most state geological surveys produce a general-interest geology publication like *Ohio Geology*, and they are all very well done. They are usually free. Some readers suggested that we consider establishing a subscription fee for *Ohio Geology*. I really don't want to do that because I am convinced that such a fee would cut our circulation drastically. I feel that citizens deserve to receive *Ohio Geology* as one of the benefits of the taxes they pay. This publication provides taxpayers with up-to-date information about the geology of the state and the critically important services that the Geological Survey provides.

In these times of rigorous economic belt-tightening, the Ohio Geological Survey has had to combine a couple of issues of *Ohio Geology* such as the last Fall/Winter issue. Our geologists and other staff are doing more with less as never before. Delays in getting this quarterly publication out have been due to formidable demands on our schedules. However, I anticipate that we will be getting *Ohio Geology* and other publications out more efficiently because we have finally obtained our own desktop publish-

#### OHIO GEOLOGY

A quarterly publication of the

Ohio Department Natural Resources  
Division of Geological Survey  
4383 Fountain Square Drive  
Columbus, Ohio 43224-1362  
(614) 265-6576 (Voice)  
(614) 265-6994 (TDD)  
(614) 447-1918 (FAX)

Editor: Michael C. Hansen

ing system.

Now I want to ask a favor of you, our readers. I ask that you send us the name and address of one other person that you feel will enjoy reading *Ohio Geology*, and will benefit from the geoscience information it contains. Consider asking your doctor, your dentist, your automotive service provider, your local librarian, your fellow teacher, your barber, your golf partner, your student, your attorney, your boss, another employee, or anyone you think would benefit from this publication to let us add them to our mailing list. It would be especially helpful to have names of people who have waiting rooms, and want to provide reading materials for customers. Please use the attached response card to send names of new subscribers. Thank you for your help, and thanks again for the outpouring of positive responses to our survey.

### READER RESPONSE TO OHIO GEOLOGY

It is always informative to receive feedback on the projects and activities we undertake. A surprisingly large number of readers of *Ohio Geology* took a moment to jot down a thought, idea, suggestion, or impression of the publication when they returned their renewal card. This was only the second time we had asked our readers to renew their subscription in 11 years of publication, primarily for the purpose of updating the mailing list in order to avoid sending *Ohio Geology* to those who no longer want it and to get correct addresses for our sometimes mobile subscribers.

Our readers are diverse and include teachers; rock and mineral club hobbyists; university professors; mineral producers; environmental, engineering, and geologic consultants; governmental planners and other governmental officials; and a lot of constituents who simply find geology to be a fascinating topic.

We received numerous suggestions for specific articles people would like to see in *Ohio Geology*, but even more comments on the general subject matter of future articles. The most frequently mentioned topic for

future articles was fossils. As one respondent noted, "Kids are really into fossils in the school system today." And, of course, there were a number of requests for publication of fossil-collecting localities. We will continue to publish articles on Ohio fossils, but we hope that much needed information will be addressed in *Fossils of Ohio*, a Survey publication now in preparation.

It was heartening to learn that many teachers use *Ohio Geology* on a regular basis in their classrooms. We will continue to include articles that will be useful to teachers. A concern for the environment was evident in a number of comments. Appreciation was expressed for the recent articles on waste disposal and other articles that addressed environmental geology issues.

We have prepared articles on Ohio's mineral industries and have treated nearly all of them in one issue or another. A number of readers commented that they particularly liked mineral industry articles that had an historical slant.

The enthusiasm for *Ohio Geology* was evident and pleasing in many readers' comments. Several individuals indicated they

would be willing to pay for a subscription. Such a commitment is encouraging, but we will make every effort to continue *Ohio Geology* as a free publication.

A few readers wondered why the Summer issue arrived in early November (and the Fall issue was equally tardy). Although I don't want to belabor this topic with intricate details, the retirement of our typesetter, a major commitment of our editorial and cartographic staff to preparations for the October 1992 Geological Society of America meeting in Cincinnati, and increasing demands on a significantly smaller staff all contributed to the delay. We apologize for this circumstance and will continue to do our best to deliver *Ohio Geology* in a timely fashion.

We appreciate your comments on *Ohio Geology* and welcome them at any time. We strive to achieve a balance in subject matter on the wonderful diversity of Ohio geology and avoid too much focus on one particular aspect. There is much yet to cover.

— Michael C. Hansen

*continued from page 1*

must have medicinal value, so the oil was marketed as Seneca Oil, "a medicine for colds, aches, pains, and what ails you."

Samuel P. Hildreth, Marietta physician, naturalist, and geologist with the first Geological Survey of Ohio in 1837, commented (1833) on the uses of petroleum:

It is at this time, in general use among the inhabitants of the county for saddle bruises, and that complaint called the scratches, in horses. It seems to be peculiarly adapted to the flesh of horses and cures many of their ailments with wonderful certainty and celerity. Flies and other insects have a natural antipathy to its effluvia, and it is used with much effect in preventing the deposit of eggs by the "blowing fly," in the wounds of domestic animals during the summer months. In neighborhoods where it is abundant, it is burned in lamps in place of spermaceti oil, affording a brilliant light but filling the room with its own peculiar odor. By filtering it through charcoal, much of this empyreumatic smell is destroyed and the oil greatly improved in quality and appearance. It is also well adapted to prevent friction in machinery, for being free of gluten, so common to animals and vegetable oils, it preserves the parts to which it is applied, for a long time, in free motion—where a heavy vertical shaft runs in a socket, it is preferable to all or any other articles.

Each of the two wells was cased with a hollow sycamore log. The 1814 well was destroyed by the construction of Ohio Route 78, but the 1816 well still survives. Its original 34-inch-diameter sycamore-log casing is remarkably well-preserved, probably as a result of it being permeated by petroleum.

Surface seeps of brine and petroleum are not uncommon in Ohio and were the first insight to early settlers of the potential presence of these commodities. Such seeps frequently emitted bubbles of natural gas, which was commonly lighted for amusement. Petroleum and natural gas had little or no commercial value, but the brine was highly desirable as a source of salt for food preservation and seasoning. The brine produced from these rocks is ancient sea water, much concentrated, that was trapped in the tiny pore spaces between mineral grains at the time of deposition of the sediments. In geological terminology, it is known as connate water.

**THE MACKSBURG FIELD**

The development of refining techniques in the mid-1800's changed the uses for petroleum and greatly increased the demand for this commodity. Soon after the Drake well was drilled in Pennsylvania the search for oil moved into Ohio, first in northeastern Ohio in Trumbull County, where shallow wells were drilled into the Berea Sandstone in the Mecca field in 1860. At about this same

time, Fulton Caldwell of Noble County visited George J. Duff of Pittsburgh, a partner with David McKee in the Duck Creek salt industry. Caldwell informed Duff that oil was well known in the Duck Creek valley and, upon returning home, sent a sample of oil from the old 1814 well to Duff. Within days, Duff was in Noble County leasing land for oil exploration. In the spring of 1860 the first well was drilled in the Duck Creek valley expressly for the purpose of recovering oil; however, commercial quantities were not found.

Exploration continued and in the fall of 1860 a well was drilled on the Washington County farm of James Dutton, south of Macksburg. At a depth of 59 feet the well began to produce about 100 barrels per day. According to John A. Bownocker, in his 1903 Survey bulletin on oil and gas in Ohio, the oil from this well was too heavy to be used for illuminating purposes, but it was found to be an excellent lubricant and was soon commanding a price of \$28 per barrel.

search for the petroleum that was now selling for \$8 to \$10 per barrel. By 1864, land prices in the valley of Duck Creek reached astronomical proportions. The 200-acre farm of Jacob Dearth, which adjoined the Dutton farm, sold for \$300,000, although, according to Bownocker, there was only one 10-barrel-per-day well on the tract—and no other productive wells were ever developed on these holdings. The Dutton farm sold for \$100,000.

The Macksburg field soon began to lose the interest of oil speculators because of a drop in price of this commodity, the expense of hauling the oil to market, and the failure of the productive zones to meet expectations. However, this field initiated oil and gas exploration in eastern Ohio and left a legacy of drillers' designations for producing zones that continues to the present.

The comparatively shallow sandstones that produced oil in the Macksburg field are of Pennsylvanian age and represent stream channels, delta distributaries, and offshore



*Outcrop of the Cow Run sandstone west of Malta, Morgan County. The sandstone at this locality exhibits a seep of petroleum. This unit was an important producer of oil in the Duck Creek valley in the 1860's. Photo by J.O. Lewis, 1916.*

Another interesting well in this field was drilled in 1861 along Cow Run, in Lawrence Township, Washington County, where Uriah S. Dye, a worker at the Harmar Bucket Factory in Marietta, noted to fellow employee John Newton that natural gas bubbled to the surface at a spring on his farm. Newton quickly organized a group of investors and leased land from Uriah Dye and adjoining acreage from Samuel Dye. The first well drilled on the Uriah Dye lease yielded no significant quantity of petroleum; however, a second well on the Samuel Dye lease struck oil at a depth of 137 feet in a sandstone that thereafter was known as the Cow Run, a term widely applied by drillers to this and other shallow sandstones in the region.

Within a short time the valley of Duck Creek between Caldwell and Macksburg was studded with derricks in a frenzied

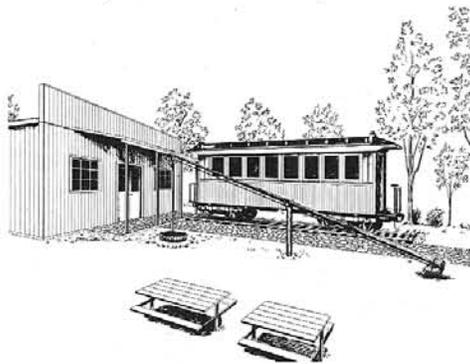
bars that were part of a complex depositional system associated with deltas carrying sediments eroded from the rising ancestral Appalachian Mountains to the east. Perhaps the most reliable characteristic of most of these rocks is their lateral discontinuity, brought about by the constant switching of distributary channels of the deltas. Consequently, most of these sandstones are very localized in their occurrence and commonly pinch out within a short distance.

The initial search for oil in the Macksburg field in the 1860's soon led to the drilling of deeper and deeper holes. The drillers gave names to each of the productive zones based upon their depth below the surface in the valley of Duck Creek. For example, the Macksburg 140 was a sandstone about 140 feet below the surface. Similarly, the Macksburg 300, 500, 700, and 800 were terms

used to designate producing sandstones in this field. Although drillers commonly use these terms to designate certain sandstones penetrated in drilling, it is unlikely that these are always the same sandstones encountered at Macksburg.

#### THE OIL WELL MUSEUM PROJECT

The site and significance of the first oil well has been known to many residents of Noble County for a number of years and also to many geologists and oil industry people. In 1971 the Salt Run Development Company acquired a 5-acre site that included the well. In 1991 this company donated the land to the Noble County Commissioners. At this time the Committee for the Preservation of the First Oil Well was formed in conjunction with the Noble County Historical Society in order to preserve and develop the site.



Artist's depiction of the proposed museum at the site of the first oil well near Caldwell, Noble County. Note the spring pole suspended over the well. The railroad car in the background represents the Bellaire, Zanesville, and Cincinnati narrow-gauge railroad that ran through the area from 1883 to 1928. Don Toth, artist. Illustration courtesy of the Committee for the Preservation of the First Oil Well.

Through donations of time, money, and materials, a parking lot has been constructed, an Ohio Historical Marker has been erected, picnic tables have been installed, and the well site has been fenced. It is the ultimate goal of the oil well committee to erect a museum on the site that would house educational exhibits. Also planned is a reconstruction of a portion of the Bellaire, Zanesville, and Cincinnati narrow-gauge railroad, which operated from 1883 to 1928 and ran through the oil-well site. It is estimated that the museum will cost approximately \$500,000. For more information on this project please contact Judith Robinson (telephone: 614-732-2306) or Dr. Sherman Smith (telephone: 614-732-5611). Donations to the museum project may be made to the Noble County Historical Society, Oil Well Fund, P.O. Box 128, Caldwell, Ohio 43724.

#### ACKNOWLEDGMENT

We thank Judith Robinson of Caldwell for assistance with this article.

#### FURTHER READING

- Bownocker, J. A., 1903, The occurrence and exploitation of petroleum and natural gas in Ohio: Ohio Division of Geological Survey Bulletin 1, 325 p.
- Collins, H. R., and Smith, B. E., 1977, Geology and mineral resources of Washington County, Ohio: Ohio Division of Geological Survey Bulletin 66, 134 p.
- Hansen, M. C., 1989, Guide to the geology along Interstate 77 between Marietta and Cleveland: Ohio Division of Geological Survey Educational Leaflet 15.
- Hildreth, S. P., 1833, Observations on the saliferous rock formation in the valley of the Ohio: American Journal of Science, v. 24, p. 46-68.
- Howe, Henry, 1907, Noble County, in Historical collections of Ohio: Cincinnati, C. J. Krehbiel & Co., v. 2, p. 349-358.
- Minshall, F. W., 1888, The history and development of the Macksburg oil field: Ohio Division of Geological Survey, v. VI, p. 443-475.
- Watkins, L. H., & Co., 1887, History of Noble County, Ohio: Chicago, 597 p.

### 1992 OHIO OIL AND GAS PRODUCTION

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

Activity for 1992 yielded mixed results: good news and bad news. The good news is Ohio oil and gas production increased slightly and that interest in the Rose Run sandstone not only bettered the 100-well mark for the third straight year but posted a higher productive rate than previous years. The bad news is a significant decline in "Clinton" sandstone wells led to the lowest drilling total in 57 years and plugging surpassed drilling for the first time ever.

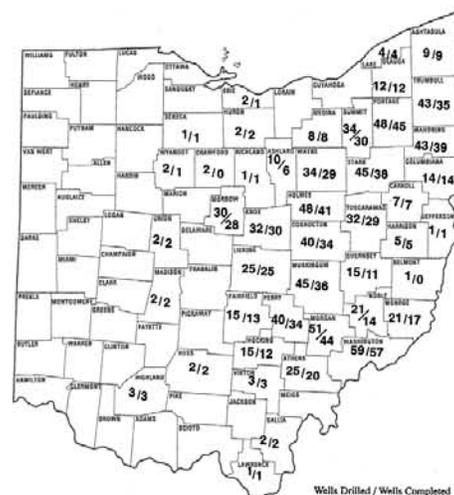
Overall permitting activity declined again in 1992, continuing the trend that began in 1985. The Division of Oil & Gas issued 2,481 permits in 1992, a decline of 17.3 percent (520) from 1991. This total includes permits issued to convert, deepen, drill, plug back, plug and abandon, reissue, and reopen. Over the year, permitting activity showed a steady increase by quarter, and the last quarter was equal to 1991 levels. The expiration of the Section 29 Tight Formation Tax Credit at the end of 1992 was an impetus for much of this last-quarter activity.

The Division issued 1,185 permits to drill for oil and gas, a 14 percent decline from last year. These permits included 1,055 new permits and 130 reissue permits. An analysis of new drill permits shows the "Clinton" sandstone to be the most actively targeted zone (49 percent), followed by deep well permits

(29 percent). Deep well permits are permits issued to formations below the Knox unconformity such as the Rose Run, Trempealeau, Rome, and Mt. Simon. Although drill-permit issuance declined, deep-well permit activity was the same as 1991.

Only 857 oil and gas wells were drilled in 1992. Thus, for the first time since 1938 the drilling total fell below the 1,000-well mark. This total is the lowest since 1935, when 736 wells were drilled. There was a decrease of 297 wells (25.7 percent) from 1991. Wells were drilled in 45 of Ohio's 88 counties, a decrease of one county from 1991.

The majority (86 percent) of Ohio wells were drilled by rotary tools. Cable-tool rigs drilled 105 wells and operated in 21 counties. Cable-tool depths ranged from 199 to 4,623 feet. The average depth per well drilled by cable tool was 1,880 feet; rotary-drilled wells averaged 4,465 feet.



New wells drilled for oil and gas in Ohio in 1992, by county.

The number of owners drilling wells declined by 11.5 percent (24 owners). Well-completion records show that 185 owners drilled wells; 93 percent (172) of these owners drilled 10 or fewer wells, including 82 owners who drilled only one well. These 172 owners accounted for 63 percent (475) of the wells drilled. The highest number of wells drilled by a single owner was 49.

Ohio oil and gas owners/operators submitted 748 well completions, representing 87 percent of the wells drilled in 1992. These reports showed that 609 wells were productive and 139 were dry holes, for an 81 percent completion rate. Average well depth was 4,102 feet, a decrease of 86 feet per well from 1991. Total depths ranged from 199 feet in the Cow Run (Athens County) to 7,950 feet in the Mt. Simon (Coshocton County). Twenty-one additional reports were received for other types of drilling operations.

Approximately 14 percent (108) of all wells completed were classified as exploratory

1992 DRILLING OPERATIONS BY TYPE OF WELL

Type of hole	Drilled	Converted	Total footage
Productive wells	609	2	2,479,503
Dry holes	139		589,139
Reopened wells	4		0
Lost holes	16		18,956
Gas storage wells	1	0	4,270
Conventional brine-injection wells	0	2	0
Enhanced-recovery wells	0	10	0
Solution-mining wells	0	0	0
<b>TOTAL</b>	<b>769</b>	<b>14</b>	<b>3,091,868</b>

wells. Thirty-eight were completed and 70 were dry holes, representing a 35.2 percent success rate, an increase of almost 8 percent from 1991. This increased success is due in part to a change in type of exploratory wells being drilled. More exploratory drilling is focused on extending field discoveries as opposed to exploring new areas. The 93 wells drilled below the Knox unconformity represented 86 percent of all exploratory drilling; 30 of these wells were productive. The Cambrian-Ordovician Rose Run accounted for 51 exploratory wells; 25 were productive. The Cambrian Trempealeau had 24 exploratory tests, of which only 4 were productive.

COMPLETION ZONES

Completion zones ranged from several shallow Pennsylvanian sandstones to the Precambrian basement rock. Washington County was again noted for the most diverse drilling activity. Wells in this county were drilled to seven different geologic zones ranging from the Pennsylvanian Wolf Creek sandstone to the Silurian "Clinton" sandstone. "Clinton" drilling declined 42 percent, accounting for the significant decline in the number of wells drilled this year.

"Clinton" sandstone

In spite of the decline, the "Clinton" sandstone has remained the most actively drilled zone since 1965. Fifty-four percent (402) of the total wells drilled in 1992 were completed in this zone, the lowest number of "Clinton" wells drilled since 1954. "Clinton" sandstone wells had a 98.5 percent completion rate and averaged 4,528 feet in depth, an increase of 86 feet per well from 1991. "Clinton" wells were drilled in 27 counties. The top five counties for "Clinton" drilling were Mahoning (38), Portage (35), Stark (35), Trumbull (35) and Summit (30). The top "Clinton" counties in 1992 would not have placed in the top five in 1991.

Rose Run sandstone

Drilling to the Cambrian-Ordovician Rose Run sandstone exceeded the 100-well mark for the third consecutive year. In 1992, 112 completion reports had been received by the reporting deadline, and that number was expected to increase to 125 wells. Rose Run wells were drilled in 11 counties by 42 operators, an increase of 7 operators. The average depth per well was 6,164 feet. Holmes County led again with 33 wells, followed by Muskingum (23) and Coshocton (22) Counties.

Although 75 percent of Ohio's estimated 925 Rose Run wells have been drilled since 1982, the significant upturn in activity began in 1987. Since 1987, 625 Rose Run wells have been drilled, and 72 percent of Rose Run dry holes have been plugged back to produce from the "Clinton" sandstone. In 1992, more wells were drilled solely as Rose Run prospects. Only 47 percent of Rose Run dry holes were plugged back to the "Clinton" sandstone.

Berea Sandstone

The Mississippian Berea Sandstone ranked third among producing formations; 82 wells were drilled in 20 counties. Morgan County had the most Berea wells (17). In addition, 16 wells were dual-completed in the Berea Sandstone and Ohio Shale in the following counties: Washington (10), Monroe (3), and Noble (3). The average depth per well was 1,138 feet.

Trempealeau dolomite

Sixty-two wells were drilled to the Cambrian Trempealeau dolomite in 1992. Morrow County continued to be the most active county for Trempealeau drilling with 23 wells. Trempealeau drilling occurred in 11 counties, a decrease of 3 counties from 1991. Wayne and Licking Counties were tied for second with 12 wells each. Thirty-four percent of all Trempealeau wells were completed as productive. The average depth per well was 4,395 feet.

Devonian shale

Drilling interest in the Devonian Ohio Shale declined 48 percent in 1992; 43 wells were drilled, compared to 70 in 1991. Washington County led Ohio Shale drilling with 17 wells, followed by Monroe County with 16 wells. The average depth per well was 2,109 feet.

TEN MOST ACTIVE COUNTIES

Washington County led the 1992 top-10 list with 59 new wells drilled. For the fourth

time in the last five years, the first-ranked county had fewer than 100 wells drilled; the only exception was Monroe County in 1989. Before 1988, the last time fewer than 100 wells were drilled in the top-ranked county was in 1961.

TEN MOST ACTIVE COUNTIES IN 1992

1992 rank	County	1991 rank	Wells drilled	Permits issued	Footage drilled
1	Washington	11	59	92	166,443
2	Morgan	9	50	106	139,529
3	Holmes	6	48	61	231,171
3	Portage	11	48	61	239,869
5	Muskingum	6	45	64	184,133
5	Stark	1	45	68	182,614
7	Mahoning	4	43	56	214,179
7	Trumbull	2	43	54	167,668
9	Coshocton	5	40	53	192,910
9	Perry	17	40	52	86,210

Top-10 counties are distributed throughout eastern Ohio in areas where the "Clinton" sandstone or multiple producing formations are being drilled. Seven of 10 counties retained top-10 status from 1991; Geauga, Monroe, and Noble Counties dropped from the 1992 list. The additions and the last time they were ranked in the top 10 are: Washington (1990), Portage (1988), and Perry (1986) Counties.

DIRECTIONAL DRILLING

Directional drilling is used to target areas where vertical drilling cannot be used, for example, acreage covered by water, areas restricted by zoning requirements, or environmentally sensitive areas such as wetlands. A directionally drilled well is commonly drilled vertically to a predetermined depth, then deviated at an angle designed to encounter the producing formation.

After an exponential increase for three straight years, applications for directional-drilling permits leveled out in 1992. Before 1989, the division issued fewer than three directional-drilling permits per year. Issuance increased to seven in 1989, doubled to 14 in 1990, and nearly tripled to 41 in 1991. In 1992, there were 39 permits issued in 7 counties. The most active counties were Mahoning (14), Trumbull (9), Portage (7), and Summit (6). Except for one, all of the directional-drilling permits issued targeted the "Clinton" sandstone and were issued in northeastern Ohio. Eight directional-drilling permits were issued to drill under Berlin Reservoir, which has been leased from the U.S. Bureau of Land Management.

PRODUCTION

Ohio's total reported crude oil production was 9,196,711 barrels, a slight increase of

38,379 barrels (0.42 percent) from 1991. Through 1992, Ohio wells have produced 1,019,885,427 barrels.

In 1992, Ohio wells produced 144,815,438 MCF of natural gas, an increase of 442,061 MCF (0.3 percent) from 1991. Gas production figures include an estimated 1,433,816 MCF of natural gas used on the lease. Through 1992, Ohio wells have produced 6,688,783,338 MCF of natural gas.

#### MARKET VALUE

The market value of Ohio crude oil decreased 3 percent in 1992 to \$174,466,178. The average price per barrel was \$18.70, a 4.6 percent decrease from the 1991 average price of \$19.61 per barrel.

Ohio natural gas production, valued at \$336,670,913, decreased 1.5 percent (\$5,179,639) from 1991. The average price paid per MCF was \$2.35 in 1992, a drop of 4 cents per MCF from 1991.

Ohio's combined oil and gas market value decreased by 2 percent (\$10,308,079) in 1992. The total dollar value was \$511,137,092, the lowest market value since 1979.

#### PLUGGING ACTIVITY

In 1992, 906 wells were plugged, an 11-well decrease from 1991. Wells were plugged in 46 counties compared to 49 counties in 1991. Perry County, second most active in 1991, replaced Ashtabula County as the most active plugging county. For the first time the number of wells plugged was greater than the number of wells drilled.

#### SUMMARY

Oil- and gas-well permitting and drilling activity continued to decline in 1992. The number of wells plugged exceeded the number of wells drilled for the first time. Directional drilling continued to be active.

"Clinton" sandstone drilling declined 42 percent, accounting for the significant decline in the number of wells drilled in 1992. Interest in the Rose Run sandstone remained strong; drilling to this formation exceeded the 100-well mark for the third straight year.

Although the total number of wells declined, drilling occurred in 45 counties. Top-10 counties were distributed throughout eastern Ohio. Overall, Ohio now has 64,729 active wells and 3,586 well owners. In 1992, these wells produced over 9 million barrels of oil and nearly 145 million MCF of natural gas. The market value of Ohio's oil and gas production exceeded \$511 million.

A copy of the full 43-page report, *1992 Ohio oil and gas developments*, may be obtained for \$3.00 from: ODNR, Division of Oil & Gas, 4435 Fountain Square Drive, Columbus, Ohio 43224, telephone 614-265-6916.

## 1992 MATHER MEDALISTS

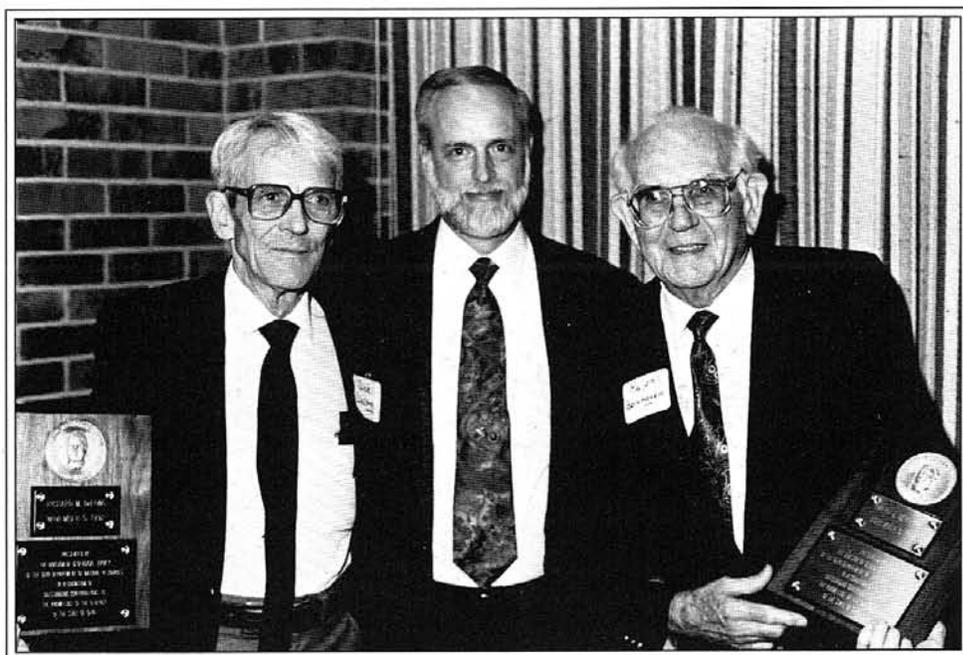
The Mather Medal is presented by the Division of Geological Survey to individuals who have demonstrated significant, life-long contributions to the geology of Ohio. The award is named after Ohio's first State Geologist, William W. Mather, who served in this capacity in 1837-1838. The medal bears a bas-relief likeness of Mather.

The Mather Medal was first awarded during the Survey's Sesquicentennial Year, in 1987. Past recipients are Myron T. Sturgeon (1987), Richard P. Goldthwait (1989), George W. White (posthumously, 1989), Jane L. Forsyth (1990), and Wayne D. Martin (1991). The 1992 honorees are former Survey employees Richard M. DeLong and Ralph J. Bernhagen. They were presented the Mather Medal in ceremonies held on November 5,

benefit the citizens of Ohio for many years to come.

Dick was born in Marion County and served in the South Pacific during World War II. After leaving military service, he attended Ohio Wesleyan University in Delaware and obtained a bachelor's degree in geology in 1950. He then pursued a master's degree in geology at The Ohio State University, where he worked under Dr. J. Osborn Fuller mapping Pennsylvanian rocks in Jackson County. After graduating in 1951, Dick went to work for the Carter Oil Company and sat on wells in Wyoming and Illinois.

In 1954, Dick returned to his native state and began his long career with the Survey. His first assignments were investigating coal and coal-bearing rocks in the state, an area of



Richard M. DeLong, left, and Ralph J. Bernhagen, right, with Mather Medals presented by Division Chief and State Geologist Thomas M. Berg.

1992, at The Ohio State University.

Mather Medalists are selected by the Mather Medal Committee of the Survey from nominations submitted by Survey staff. The Mather Medal Committee for 1992 consisted of E. Mac Swinford (chairman), Donald E. Guy, Jr., Glenn E. Larsen, Sherry L. Weisgarber, and Garry E. Yates.

#### RICHARD M. DELONG

Richard M. DeLong retired from the Division of Geological Survey in 1988, after 34 years of continuous service. During this long interval, Dick produced many reports and maps and gathered a significant amount of geologic data from his many journeys into field areas in eastern Ohio. This work will

research that would be his primary focus for the remainder of his career at the Survey. Dick published 11 Reports of Investigations and coauthored two major bulletins—*Geology of Stark County* (with George W. White) and *Coal resources of Ohio* (with Russell A. Brant). Dick also mapped Harrison County. Altogether, Dick mapped the geology of more than 1,500 square miles of Ohio during his 34-year career with the Survey. He measured numerous stratigraphic sections, which are a formidable contribution to our database, during his many long days in the field.

In many ways, Dick's greatest contribution to the citizens of Ohio may be the 189 maps in the Abandoned-Underground-Mine Map Series, which he completed late in his

career with of assistance of Survey geologist Douglas Crowell. These maps depict the location and extent of thousands of abandoned underground mines in eastern Ohio. The data were compiled from original mine maps, many of which were prepared by mining engineers in the last century, and transferred onto mylar copies of U.S. Geological Survey 7.5-minute quadrangle maps. These maps are one of the most popular items available at the Survey and are used by a wide variety of individuals, industry, and governmental agencies.

Dick was able to use his mapping skills to prepare two popular educational publications—the geologic maps of the Hocking Hills and Flint Ridge areas, published in 1967 and 1972, respectively. Each publication has a geologic map on one side and educational text, including color photos, on the other side. They continue to be popular items.

The career of Richard M. DeLong was characterized by hard work and dedication to understanding the geology of Ohio, particularly the complex rocks of Pennsylvanian age in the eastern portion of the state. He left a legacy of publications and data that will continue to be of importance and value to Ohio geology.

#### RALPH J. BERNHAGEN

Ralph J. Bernhagen has the distinct honor of being one of only 11 individuals to hold the position of State Geologist of Ohio during an interval of 155 years. He served in this capacity from 1957 to 1968, but his contributions to the geology of Ohio span a considerably longer interval.

Ralph, known to most of his friends and colleagues as "Bernie," is a native of Toledo. He began his university education in 1929 at Michigan State University and continued at the University of Toledo, majoring in business administration. He then transferred to The Ohio State University, where he received a B.A. degree in geology in 1937 and an M.A. degree in geology in 1939. After graduation, Bernie worked for Shell Oil Company and an engineering firm in Houston, Texas, until 1941, when he returned to Ohio to serve as a geologist on the Ohio Water Supply Board.

The Water Supply Board became the Division of Water in 1949 when the Ohio Department of Natural Resources was organized. Bernie, who had been chief geologist for the board, assumed the position of Assistant Chief of the Division. He held this position until 1952, when he transferred to the Division of Geological Survey as Assistant Chief under John Melvin. Bernie became the ninth State Geologist of Ohio in 1957.

At the time Bernie became Chief, the Survey was quartered in Orton Hall, the home

of the Department of Geology, at The Ohio State University. The facilities were cramped for both organizations; some Survey personnel were quartered in war-surplus buildings on Hardin Road (neither the road nor the buildings exist any longer). The Morrow County oil boom in the early 1960's, and the consequent demand for geologic information, necessitated that the Survey find a new facility. Bernie was responsible for moving the Survey to offices in Grandview Heights in 1963, a facility that would house the Survey until 1973.

Bernie was responsible for organizing the Lake Erie Section of the Survey in 1961 when the duties of the former Division of Shore Erosion were transferred to the Survey. Five new employees and a 46-foot research vessel, rechristened the *GS-1*, became part of the Survey and its new efforts in studying coastal erosion and other geologic aspects of Lake Erie.

A cooperative program with the U.S. Geological Survey to provide 7.5-minute (scale 1:24,000) topographic quadrangle maps for Ohio had been initiated by John Melvin, and it fell onto Bernie to implement the mapping when he assumed the duties of Chief of the Survey. This six-year, \$6.5-million project produced 788 quadrangle maps, and Ohio became the first state to have complete coverage at the 1:24,000 scale.

In 1968, Bernie left the Survey to become Chief of the Water Planning Section in the Department of Natural Resources and thus returned to his first scientific passion, ground water. In 1974, he became coordinator of the Lake Erie Harbors Program in the Department. In 1988, Bernie retired from the Department of Natural Resources after 47 years of serving the citizens of Ohio. The accomplishments noted above and many others, including publication of more than 20 papers and reports, are just a sampling of the contributions of Ralph J. Bernhagen to Ohio geology.

---

### THE TRENTON LIMESTONE OF NORTHWESTERN OHIO

The Division of Geological Survey recently released Report of Investigations No. 143, *Stratigraphy, structure, and production history of the Trenton Limestone (Ordovician) and adjacent strata in northwestern Ohio*. This 78-page report was authored by Survey geologist Lawrence H. Wickstrom and former Survey geologists John D. Gray and Ronald D. Stieglitz.

The Trenton Limestone in northwestern Ohio and adjacent parts of Indiana was the reservoir rock for the largest oil and gas field in the world from the late 1800's through the early 1900's and was the target of approxi-

mately 100,000 wells, 76,000 of them in Ohio. It was the first true giant oil and gas field discovered in the United States. More than 380 million barrels of oil and 1 trillion cubic feet of natural gas were produced from this area, known as the Lima-Indiana oil and gas trend.

The first well in this field was drilled in 1884 by Dr. Charles Oesterlin, a champion of the possibilities of large quantities of hydrocarbons in the area, on his farm east of Findlay. This discovery well produced 250,000 cubic feet of gas per day, which created considerable excitement and spurred additional drilling. The Karg well, drilled in Findlay in 1886, was perhaps the most famous of any of the wells. Between 20 and 50 million cubic feet of natural gas per day roared from the well and, for the first five days, no fires were lighted in Findlay for fear of igniting the gas. Eventually, a 10-foot standpipe was erected 200 feet away from the well and lighted. The flame shot more than 100 feet in the air and could be seen 25 miles away in Bowling Green.

Findlay and surrounding communities became boom towns and advertised free gas to industries who would locate there. Oil and natural gas were regarded as inexhaustible, despite pleas to the contrary by State Geologist Edward Orton. It was not too long before the wasteful practices had exhausted the gas and depressurized the field. The history of this oil and gas field is one of the most interesting chapters in the history of the state and is summarized in considerable detail in RI 143.

Much of the focus of this report is a modern analysis of the geology of the Trenton and adjacent units in the area. Stratigraphy, structure, depositional environments, dolomitization models, and the production of oil and gas are discussed in considerable detail. The report is accompanied by a large, folded sheet of seven stratigraphic and structural cross sections of northwestern Ohio. Thirty figures, including numerous isopach and structure-contour maps, accompany the text. Much new information on faulting in the region is presented. An extensive appendix lists wells used in compiling the report. Log tops of significant units are given for each well.

Report of Investigations No. 143 is available from the Division of Geological Survey for \$8.35, which includes tax and mailing. In addition, eight geophysical-log stratigraphic cross sections across northwestern Ohio are available on open file at a vertical scale of 1 inch = 100 feet. Four of these cross sections are published at a reduced scale in RI 143. The open-file cross sections are \$4.00 each plus tax and mailing. Please contact the Sub-surface Stratigraphy and Petroleum Geology Section (telephone: 614-265-6585) for more information.



## "OHIO GEOLOGY" PINS AVAILABLE

The Division of Geological Survey has produced a cloisonné pin featuring a stylized geologic map of Ohio on a white background with the words "Ohio Geology" in gold letters. Each geologic system is represented by a different color. The 1-inch by 3/4-inch pins are accompanied by a 2-inch by 3 1/2-inch card that has each geologic system labeled and an explanation of the geologic map of Ohio.

These pins can be used as either lapel pins or tie tacks and help to promote the importance of geology in Ohio. The pins are \$2.00 each. Mail orders should be accompanied by an additional \$0.12 state sales tax (shipped to Ohio addresses only) and \$0.29 mailing. Quantity discounts are available. Please contact the Division of Geological Survey, 4383 Fountain Square Drive, Columbus, Ohio 43224-1362. Telephone: 614-265-6605.

## SURVEY COMINGS

Raymond O. Klingbeil, Cartographer, Technical Publications Section.

## QUARTERLY MINERAL SALES, OCTOBER–NOVEMBER–DECEMBER 1992

compiled by Sherry L. Weisgarber

Commodity	Tonnage sold this quarter <sup>1</sup>	Number of mines reporting sales <sup>1</sup>	Value of tonnage sold <sup>1</sup> (dollars)
Coal	6,794,348	134	\$189,035,287
Limestone/dolomite <sup>2</sup>	13,469,804	95 <sup>3</sup>	49,749,679
Sand and gravel <sup>2</sup>	11,428,695	233 <sup>3</sup>	38,539,319
Salt	910,040	4 <sup>4</sup>	9,160,685
Sandstone/conglomerate <sup>2</sup>	400,362	21 <sup>3</sup>	6,955,223
Clay <sup>2</sup>	611,630	28 <sup>3</sup>	2,293,920
Shale <sup>2</sup>	327,624	20 <sup>3</sup>	474,417
Gypsum <sup>2</sup>	50,725	1	481,888
Peat	2,996	4 <sup>3</sup>	23,226

<sup>1</sup>These figures are preliminary and subject to change.

<sup>2</sup>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.

<sup>3</sup>Includes some mines which are producing multiple commodities.

<sup>4</sup>Includes solution mining.

## 1992 OHIO MINERAL SALES<sup>1</sup>

compiled by Sherry L. Weisgarber

Commodity	Tonnage sold in 1992 <sup>2</sup>	Number of mines reporting sales <sup>2</sup>	Value of tonnage sold <sup>2</sup> (dollars)	Percent change of tonnage sold from 1992 <sup>2</sup>
Coal	28,904,245	192	\$780,457,381	-1.7
Limestone/dolomite <sup>3</sup>	53,141,472	120 <sup>4</sup>	196,066,766	+5.8
Sand and gravel <sup>3</sup>	44,745,704	324 <sup>4</sup>	151,281,515	+4.6
Salt	2,932,494	5 <sup>4</sup>	43,823,446	+9.8
Sandstone/conglomerate <sup>3</sup>	1,851,408	33	33,135,795	+10.2
Clay <sup>3</sup>	2,404,430	48 <sup>4</sup>	8,898,091	-8.3
Shale <sup>3</sup>	2,119,665	33 <sup>4</sup>	3,049,362	+15.2
Gypsum <sup>3</sup>	205,025	1	1,947,739	+2.6
Peat	17,483	4 <sup>4</sup>	190,432	-6.0

<sup>1</sup>The sums of previously reported quarterly totals may not necessarily equal the annual totals reported here owing to the receipt of additional information or corrections to previously reported figures.

<sup>2</sup>These figures are preliminary and subject to change.

<sup>3</sup>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.

<sup>4</sup>Includes some mines which are producing multiple commodities.

<sup>5</sup>Includes solution mining.

## OHIO'S MINERAL INDUSTRIES TEACHERS WORKSHOP

The seventh annual Ohio's Mineral Industries Teachers Workshop will be held July 12-16, 1993, at the ODNR complex in Columbus. For more information on the 1993 workshop, contact Dr. Roger Bain, Department of Geology, University of Akron, Akron, Ohio 44325-4101 (telephone 216-972-7659), or Sherry L. Weisgarber, ODNR, Division of Geological Survey, 4383 Fountain Square Drive, Columbus, Ohio 43224-1362 (telephone 614-265-6588).

Ohio Department of Natural Resources  
Division of Geological Survey  
4383 Fountain Square Drive  
Columbus, Ohio 43224-1362



BULK RATE  
U.S. POSTAGE  
PAID  
Columbus, OH  
Permit No. 5767

Address Correction Requested

Total copies printed: 3500  
Unit cost: 029  
Publication date: 7/93