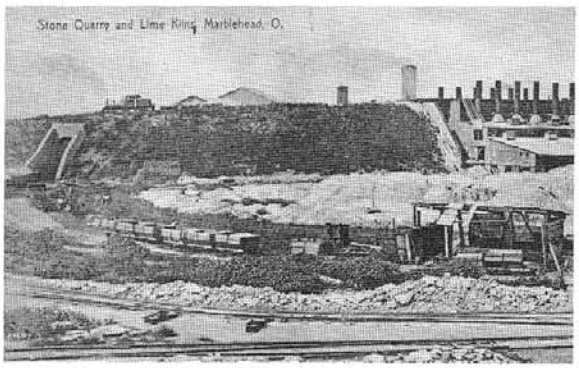
Ohio Geology Newsletter

FALL 1985

Division of Geological Survey

LIMESTONE AND DOLOMITE IN OHIO

Limestone, and the closely related rock dolomite, have been characterized as the most versatile and widely used rocks in the earth's crust. The tremendously important and diverse uses of these rocks are seldom flashy and "high tech," but a modern industrial society would find it difficult to function without them. Fortunately, limestone and dolomite are abundant and easily extracted in many areas; Ohio has a nearly limitless supply of these rocks located near major markets. The state thus has a competitive edge because of lower transportation costs for these low-cost-per-unit commodities.



Quarry in the Columbus Limestone (Devonian) and lime kilns on the Marblehead Peninsula, Ottawa County, circa 1900. From a postcard in David A. Stith collection.

The limestone and dolomite industry is an old one in Ohio, going back to the beginnings of European settlement of the state. It has only been since World War II, however, that the demand for these commodities has skyrocketed, although there have been significant fluctuations of the market during this time. Ohio, owing to both abundant resources and nearby major markets, is one of the leading states in both production and consumption of limestone and dolomite.

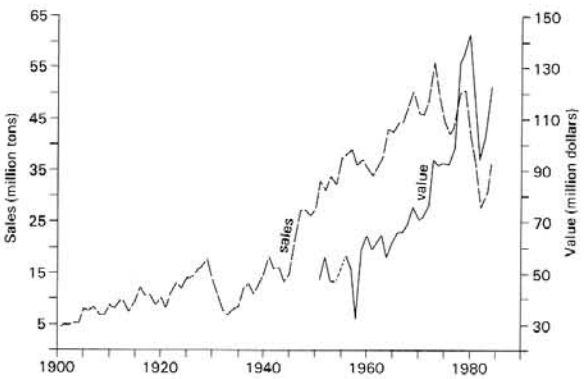
ORIGIN OF CARBONATES

Limestone is composed of calcium carbonate, $CaCO_3$, in the mineral forms of calcite or aragonite, and generally contains various impurities, particularly small amounts of clay and quartz. A closely related rock is dolomite, which contains 90 percent or more of the mineral dolomite, $CaMg(CO_3)_2$. As can be ascertained from the chemical formula, the mineral dolomite differs from the mineral calcite by the presence of magnesium. Collectively, limestone and dolomite are termed carbonate rocks.

Carbonate rocks in Ohio owe their existence principally to warm, shallow seas that covered the state during much of the Paleozoic Era. In addition, less widespread, although locally important, carbonates were deposited in nonmarine lakes. The marine carbonates were deposited during times of low clastic (sand, silt, and clay) input into the sea by rivers flowing on adjacent land areas.

Essential to the formation of these carbonate sediments in the sea was the presence of plants and animals. Indeed, many carbonate rocks are composed almost entirely of the remains of various invertebrate animals (brachiopods, bryozoans, clams, corals, crinoids, snails, etc.) with skeletons composed of calcium carbonate or of plants, particularly algae, that precipitate calcium carbonate.

Most dolomites are thought to have been produced soon after deposition of lime muds on the sea floor by the replacement of the calcium carbonate by magnesium carbonate, a process known as dolomitization. Some dolomites are thought to be primary in origin, that is, they were directly deposited in the sea as magnesium carbonate rather than formed by replacement. Some of these primary dolomites are thought to have been formed in a high-salinity environment.



Sales and value of limestone and dolomite in Ohio. Value line dashed where data not available.

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ODNR
OHIO DEPARTMENT OF NATURAL RESOURCES

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

Chief's corner by Horace R. Collins

The work of the Division of Geological Survey in advancing the frontiers of geological knowledge in Ohio has been greatly aided recently by the generosity of the France Stone Company. France Stone, through its Chairman of the Board, Mr. Clair Martig, has donated a Mobile B-50 drill rig complete with tools to the Division.

It has long been recognized that core-drilling capability is vital to the Geological Survey in order to adequately map and characterize the geology of the state. Accordingly, the Division acquired a Mobile B-61 core-drilling rig in the spring of 1981. Even though this rig has been of great benefit to the Survey and, in fact, has recently set a drilling record (see p. 7, this issue), a single drill rig is not adequate to gather data for current and projected programs. Bedrock mapping, for example, is currently underway in eight counties. Without drilling capability, geologic observations are restricted to road cuts, quarries, and outcrop exposures—a severe limitation to an adequate description of the geology of a county. By using a core rig, however, data can be obtained at virtually any locality within a county. The recovery of core samples is absolutely indispensable for determining the physical and chemical quality of deeper rock units. Mining in Ohio for the most part has been confined to either open-pit operations or the extraction of relatively shallowly buried deposits. Our knowledge of mineral resources is, therefore, largely confined to shallow, easily accessible deposits. The deeper mineral wealth of the state is essentially unknown.

Private industry does considerable drilling for its own purposes and commonly such data are shared with the Division of Geological Survey. However, industry drilling generally is confined to small property areas and normally only deals with a single mineral commodity. Additionally, industry is under no obligation to systematically investigate the geology and mineral resources of the state or for that matter to share proprietary data with competing industries or regulatory agencies. The Geological Survey, on the other hand, is in a position, and in fact is under legislative mandate, to investigate and make public all aspects of geology and mineral resources and to perform such services on a systematic, statewide basis. The Geological Survey thus, through its drilling programs, provides a broad-brush approach to exploration for mineral resources on which private industry can base its more detailed and more closely focused exploration programs. This approach is proving to be fruitful in Ohio.

The Division of Geological Survey and the citizens of Ohio are fortunate to have leaders of industry such as Clair Martig of the France Stone Company, who had the foresight to look into the future of Ohio and its geology and mineral resources and make a meaningful commitment to that future.

OHIO GEOLOGY

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Editor: Michael C. Hansen
Secretary: Donna M. Swartz
Layout and design: Philip J. Celnar
Phototypist: Jean M. Lesher

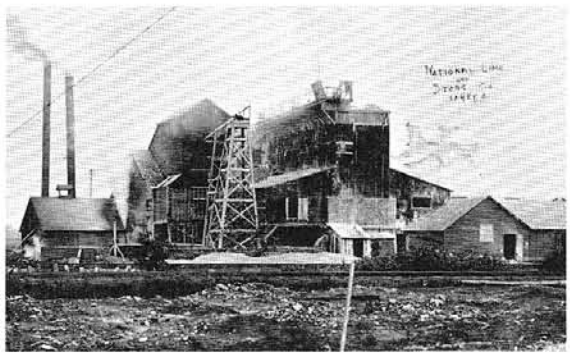
News items, notices of meetings, etc. should be addressed to the attention of the editor. Change of address and new subscriptions should be addressed to the attention of the secretary.

continued from page 1

Many of the limestones and dolomites in Ohio are in the form of thick, widespread beds that reflect the distribution of the extensive Paleozoic seas and, to a degree, the length of time a particular marine invasion maintained a stable and unchanging environment. Some deposits of carbonate rocks, particularly those deposited during the Pennsylvanian Period in eastern Ohio, are of limited lateral distribution and irregular in thickness. This circumstance reflects the rapidly changing environments in this part of the state during this period of geologic history.

HISTORY AND PRODUCTION OF CARBONATES IN OHIO

The abundant and widespread outcrops of limestone and dolomite in Ohio attracted interest as soon as European settlement began in the region. Loose blocks of these rocks ("fieldstone") were used as building stones for foundations, chimneys, fences, and other structures. These settlers probably realized at an early date that some of the limestones could be burned and reduced to quicklime for making mortar and plaster. William W. Mather, first State Geologist of Ohio, stated in 1838 that "limestone is undoubtedly the most valuable building material among the rocks of Ohio."



Processing facility of National Lime and Stone Company at Carey, Wyandot County, circa 1909. From a postcard in David A. Stith collection.

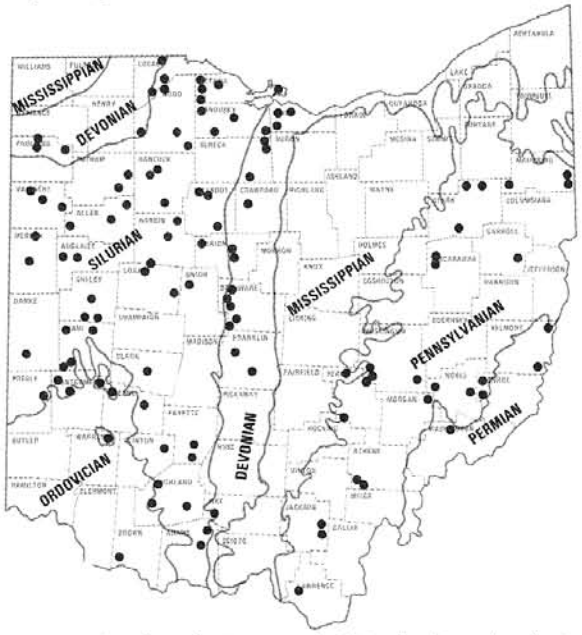
It is uncertain as to when commercial quarrying of limestone and dolomite began in the state, but it was certainly at an early date, probably in the late 1700's or early 1800's. Early quarries required thin-bedded carbonate rocks that could be

easily pried apart as slabs. With the advent of steam drills, sawing equipment, and blasting techniques, the limestone industry was able to utilize a greater variety of rocks in large-scale, commercial ventures. The progressive industrialization of the state during the 1800's created an increasing demand for carbonate rocks. Of particular importance were limestones in southern Ohio that were used for flux stone in the charcoal iron furnaces of the Hanging Rock district. The iron industry began in Ohio in 1804 and 224 separate iron furnaces were in operation at one time or another. The abundance of local sources of suitable limestone was in no small way influential in the growth of the steel industry in Ohio.

Putnam Hill limestone (Pennsylvanian) cropping out above the Carl Crabtree mine in the Tionesta clay, Muskingum County. Photo by Wilber Stout, circa *1915.*

The former importance of limestone and dolomite as building stones can be seen in many areas of the state, particularly in western Ohio, where schools, churches, public buildings, and private residences exhibit both the beauty of local limestones and the craftmanship of stonemasons who constructed these edifices.

Of particular interest to many Ohioans is the Ohio State House in Columbus, which was constructed in the mid-1800's of Columbus Limestone (Middle Devonian age) extracted from nearby quarries along the Scioto River that were known, appropriately, as the State House Quarries. Today, Ohio limestone and dolomite have been largely replaced by other materials as a building stone and only a few operations produce a minor amount of carbonate dimension stone, mainly in the form of rubble stone.



Generalized geologic map of Ohio showing the distribution of active (1984) limestone and dolomite quarries that reported production to the Division of Geological Survey.

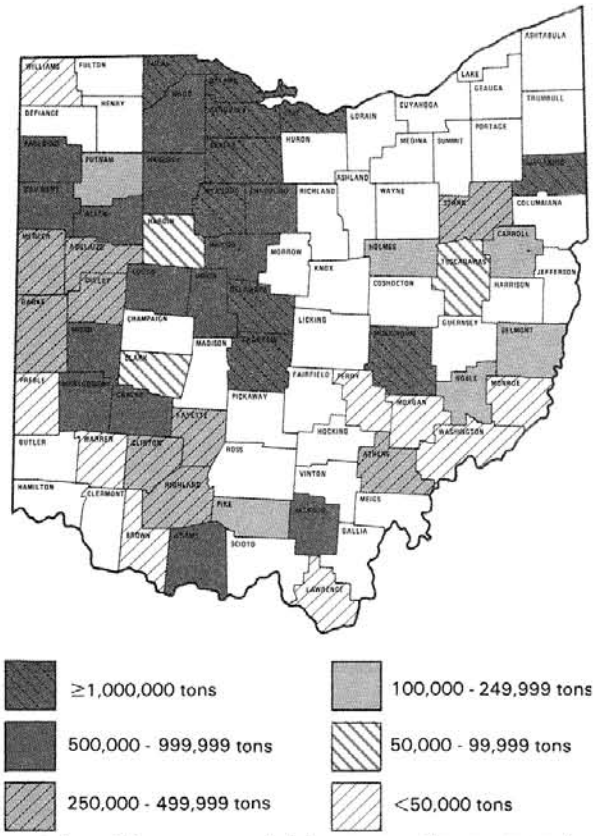
GEOLOGY OF CARBONATE ROCKS IN OHIO

Limestone or dolomite occurs in every geologic system exposed at the surface in Ohio and at one time or another has been mined from each of these geologic subdivisions. By far, the greatest volume and the largest quarries are in rocks of Silurian age that are exposed or near the surface in much of the western half of the state. As of 1984, a total of 62 quarries were extracting either limestone or dolomite from 10 different geologic units in Silurian rocks. Next in importance, volumetrically, are quarries in rocks of Devonian age, with a total of 23 operations in five different geologic units.

Twenty-four quarries are active in rocks of Pennsylvanian age in eastern Ohio, where eight different geologic units are currently being mined. Of lesser importance are Mississippian rocks (four operations in one geologic unit) and Ordovician and Permian rocks (one operation each). Nonmarine limestones and dolomites occur only in Pennsylvanian and Permian rocks in eastern Ohio and a few of these units are mined as a source of carbonate rock.

PRODUCTION

Limestone or dolomite is currently produced in 51 counties from 115 operations, and more than 1,400 people are directly employed in this activity. Many thousands of additional workers are employed in industries that depend directly on these rocks and their products. Leading counties in production of carbonate rock are Erie, Sandusky, Franklin,



Sales of limestone and dolomite in Ohio in 1984, by county.

Wyandot, and Mahoning.

All of the 115 operations use open-pit techniques, that is, surface quarries, to extract limestone or dolomite. Successful siting of a quarry depends not only on a deposit of carbonate rock of sufficient quality and thickness, but also on the presence of relatively thin overburden (overlying rock or glacial sediment of no value), the proximity of markets, transportation facilities, and local zoning ordinances.

In these open-pit quarries, mining techniques commonly involve drilling holes along a bench above a highwall and placing explosive charges in the holes. When blasting occurs, the massive limestone or dolomite is fractured into blocks, most of which are then hauled to nearby crushing and processing facilities. Some large blocks not shattered sufficiently in the blast may require additional explosives or on-site crushing. In many quarries, layers of limestone are extracted at various levels or benches. Benching facilitates quality control where various layers of carbonate rock may have slightly different chemical or physical properties that make them more suitable or less suitable for particular uses.

Some quarries in the state are in the fortunate position of being able to produce multiple mineral commodities from the same excavation. In addition to limestone or dolomite, some quarries produce sand and gravel from Pleistocene outwash overlying the carbonate rock. Other quarries, particularly some of those in rocks of Pennsylvanian age in eastern Ohio, produce clay, shale, or coal in addition to limestone.

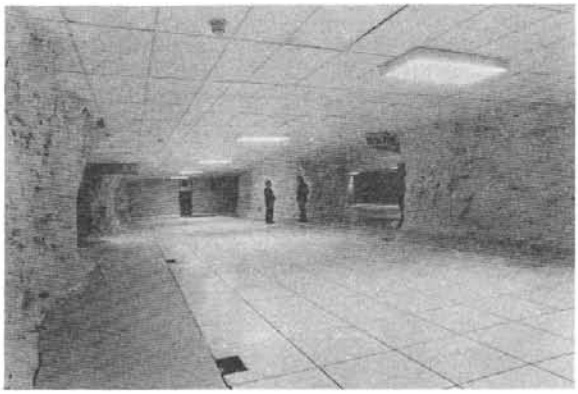
Limestone and dolomite quarries tend to be long-term operations at a particular site, as the acreage consumed by mining activities is relatively small in comparison to operations such as surface coal mines or many sand and gravel operations. Reclamation of the quarry site is not plagued by problems with acidic water as are coal mines and, indeed, some abandoned limestone or dolomite quarries have been developed into prime building sites with highwalls and lakes in the abandoned quarries used to advantage in scenic landscaping.

Until recent years there were four active underground limestone mines in Ohio. Two of these mines were shaft operations, that is, the desired limestone layer was reached by means of a vertical shaft from the surface. The other two mines extracted limestone by means of a drift mine, that is, the mine was a horizontal tunnel driven from the outcrop.

One of the shaft mines was at Barberton, in Summit County, where a vertical shaft descended to the Columbus Limestone (Devonian) at a depth of about 2,300 feet. The Barberton mine was the deepest limestone mine in the world until it closed in 1976. The other shaft mine in Ohio was in the Maxville Limestone (Mississippian) at Ironton, Lawrence County.

The last mine to extract limestone from an underground operation in Ohio was a drift mine near East Fultonham in Muskingum County. The Jonathan mine, which ceased active mining in 1982, utilized the Maxville Limestone (Mississippian) for portland cement. A crushing and processing facility, for Maxville Limestone from a nearby quarry, is still located in this mine.

Ohio's other limestone drift mine has long ceased operation as a producer of carbonate rock; however, it is still a busy place. This 250-acre mine in the Brassfield Limestone (Silurian) near Lewisburg in Preble County is now the location for several enterprises that require or utilize attributes provided by an underground environment. These uses include wine storage, mushroom growing, a distribution center for dressed chickens, and archival storage of computer tapes and disks for businesses. This latter operation, carried out by Secured Data Services, Inc., of Centerville, uses about 2 acres of the spacious room-and-pillar mine to store computer data. The constant temperature and fireproof nature of the mine provide an ideal environment for such activities.



Computer-data storage facility of Secured Data Services, Inc., in an abandoned underground limestone mine near Lewisburg, Preble County. Photo courtesy of Secured Data Services, Inc.

USES

The major portion (about 65 percent) of carbonate rock produced in Ohio is crushed for use as construction aggregate, a use for which demand has tripled in the last century, although there has been a decline in demand since 1970. The fragments of carbonate rock are graded to size and are used as a base for roads, a surfacing for rural roads (road metal), as railroad ballast, as fill in construction projects, as riprap, and as an aggregate in concrete and bituminous concrete.

Another large portion of carbonate rock extracted in Ohio is pulverized into fine powder for use as agricultural lime (aglime), a commodity that is spread on farm fields as a soil conditioner. Another important use for pulverized limestone is rock dusting in coal mines. The lime dust is used as a coating on the mine walls in order to dilute the concentration of coal dust below potentially explosive limits. Light-colored limestone of high purity is pulverized for use as a filler (whiting) in the production of paint and plastics.

In some of the more important uses of carbonate rock the stone receives additional treatment after crushing. Of particular importance is cement, made from limestone that is ground to a fine consistency and mixed with clay or shale, in the ratio of two parts limestone to one-half part clay. The mixture of ground limestone and clay is fed into a long, firebrick-lined tube, known as a rotary kiln, where it is heated to about 2,900°F. The partially melted mixture emerges as clinker, which is ground fine and mixed with a small amount of gypsum to regulate setting time. The finished product is cement, a commodity of vital importance to the construction industry.

Pulverized limestone is subjected to treatment to produce quicklime and hydrated lime—two products that have widespread industrial applications. Quicklime is produced by heating limestone in a kiln to drive off carbon dioxide (CO_2) so that only calcium oxide (CaO) remains. Quicklime is unstable and will absorb atmospheric carbon dioxide and revert to calcium carbonate ($CaCO_3$); therefore, quicklime must be stored under dry, CO_2-free conditions. Quicklime commonly is converted to a more stable condition by the

addition of water to form a product known as hydrated lime.

Ohio ranks first in the nation in production tonnage of lime and second in consumption of this commodity. In 1983, 11 companies at 14 plants produced 1.9 million tons of lime valued at 84.9 million dollars. This tonnage total was about 13 percent of U.S. production, a slight decrease from the peak year of 1978, when Ohio captured 17.2 percent of the market.

The uses for lime are many and varied and include steel making, in which about 150 pounds of quicklime are used for each ton of steel produced. In the steel-making process, lime serves as a flux to combine with impurities such as alumina, phosphorus, silica, and sulfur to form a silicate slag, which is then drawn off. Lime is used in sewage and waste treatment, where it removes nitrogen and phosphorus compounds, and in water treatment as a softener, a control for bacteria, and an aid in the removal of suspended solids. Other important environmental uses of lime include neutralization of acid drainage from abandoned coal mines and in stack scrubbers at coal-fired power plants, where a lime slurry is sprayed into the gases rising up the stack. The lime combines with sulfur dioxide in the stack gases and forms calcium sulfate sludge.

In the chemical industry, lime is used in the production of alkalis such as caustic soda and soda ash, bleaches, fertilizers, organic chemicals, paint pigments, and pesticides. In addition, lime is used in the production of glass and paper and in food processing, particularly the making of sugar.

Although, volumetrically, many of these uses of carbonate rock are small in comparison to the overall quantity of limestone and dolomite produced in the state, each one is nevertheless important to the industrial and environmental success of Ohio's economy. The abundant resources of carbonate rock in the state and their proximity to major markets are in no small degree responsible for the economic security of many Ohio industries.

Aerial view of a quarry in the Columbus Limestone (Devonian) and loading dock (top arrow) on the Marblehead Peninsula, Ottawa County, 1949. Limestone quarrying activities have been continuous in this area since the last century. Kelleys Island has also been the site of extensive limestone quarries.

Production of limestone and dolomite in Ohio for all uses has been on a steady upward climb since the turn of the century and has shown a particularly dramatic increase in the years since World War II. Much of this demand was in conjunction with construction of interstate highways in the 1950's and 1960's. Production of carbonate rock reached an all-time high in 1979 with 50.8 million tons being produced; however, economic recession in the early 1980's caused production to plunge to 27.6 million tons, a 20-year low. There has been a gentle recovery and a climb towards the 1979 production figure in the past two years. Sales of limestone and dolomite are thus directly tied to general conditions of the economy, particularly construction activities and industrial processes that require these commodities. In addition, price and sales of lime are in part related to energy costs, as production of quicklime from limestone is an energy-intensive activity. As major road-building activities decline there are new potential markets for carbonate rocks. One of particular importance to the Ohio coal and carbonate industries is the use of the fluidized-bed process for removal of sulfur compounds from coal in coal-fired boilers. Large-scale implementation of this process would not only greatly increase the demand for carbonate rock but would also create substantial markets for Ohio's high-sulfur coal.

—Michael C. Hansen

ADDITIONAL READING

Bates, R. L., and Jackson, J. A., 1982, Our modern stone age: Los Angeles, William Kaufman, Inc., 132 p.

Lamborn, R. E., 1951, Limestones of eastern Ohio: Ohio Geological Survey Bulletin 49, 377 p.

Ohio Geological Survey, 1959, A century and a half of Ohio's minerals: Ohio Geological Survey Information Circular 24, 61 p.

Annual report on Ohio mineral industries (Prior to 1981 published as Division of Mines report by the Ohio Department of Industrial Relations).

Stout, Wilbur, 1941, Dolomites and limestones of western Ohio: Ohio Geological Survey Bulletin 42, 468 p.

ROSS COUNTY GLACIAL GEOLOGY

The Survey recently released Report of Investigations No. 127, *Glacial geology of Ross County, Ohio,* by Michael J. Quinn and Richard P. Goldthwait. This publication consists of a 42-page text with 31 figures and 17 tables and a color map, at a scale of 1:62,500, which depicts the distribution of glacial deposits in the county. The map also shows contour lines drawn on the bedrock surface (top-of-rock).

Ross County is located on the glacial boundary, and complex deposits of the Illinoian- and Wisconsinan-age glaciers are preserved within portions of the area. Lake deposits known as the Minford Silt, thought to have been associated with the Kansan-age glaciation, also are present in Ross County. Copies of the report and map are available from the Survey for $12.30, which includes tax and mailing.

OHIO AND KENTUCKY AGREE ON BOUNDARY

A boundary dispute between Ohio and Kentucky, dating back to the creation of the Northwest Territory in 1785, has finally been settled by the U.S. Supreme Court. Their 1980 decision, defining the boundary between the two states as the 1792 low-water mark of the northern shore of the Ohio River, was finally implemented in April 1985 upon completion of a detailed investigation of old records that contained information on the position of the river.

The U.S. Geological Survey has published a set of 29 planimetric quadrangle maps, at a scale of 1:24,000, that depict the agreed upon border between Ohio and Kentucky. These maps are available from the Ohio Geological Survey for $6.53 each, which includes tax and mailing. Please order by topographic quadrangle name. An index to topographic maps for Ohio is available from the Survey at no charge.

RECENT OHIO EARTHQUAKES

From 1983 through 1985, 13 small earthquakes have been recorded in the state of Ohio by the Seismological Observatory of the University of Michigan. In addition, two small earthquakes, one of which was felt in part of Ohio, occurred in the border region of the state.

Four earthquakes in 1983 were from the same location in eastern Shelby County at the site of six small earthquakes in 1980 and 1981 (see *Ohio Geology*, Winter 1982). The 1983 quakes, along with the earlier ones, all measured about 2.0 or less on the Richter scale—too small to be felt locally. The significance of this cluster of microearthquakes is uncertain, but this general area has been the source of at least 35 earthquakes that were felt by local residents, including two damaging events in March 1937. Two microearthquakes occurred in 1985 in western Auglaize County, near the epicenters of the 1937 quakes, which were the most intense ones ever recorded in Ohio. It is probable that numerous other microearthquakes have occurred in this area, but it was not until the establishment of the "Anna array" of seismographs by the University of Michigan in the late 1970's that such small events could be recorded.

A small earthquake, apparently not felt by local residents, was recorded in 1983 near Hamilton on the Hamilton-Butler County line. This general area has been the source of five earthquakes that were felt locally in the 1920's and 1930's.

Two earthquakes, one in late 1983 and one in early 1984, were recorded in the Toledo area in Lucas County; one of these, with a Richter magnitude of 2.6, was felt by local residents. Newspaper reports indicated that the principal phenomenon experienced by numerous individuals during this quake was the rattling of dishes. Lucas County has been the site of four previous felt earthquakes, which occurred in the 1920's, 1940's, and 1950's.

A small earthquake was recorded instrumentally beneath Lake Erie, offshore from Lake County in northeastern Ohio, in 1983. Although this earthquake had a Richter magnitude of 2.7, large enough to be felt locally, no residents along the Lake Erie shoreline reported any vibratory phenomena. In part, this circumstance may be related to the occurrence of this earthquake in the early morning hours. Northeastern Ohio, including Lake County, has been the site of numerous small earthquakes.

Putnam County was the site of a small earthquake in 1985,

Ohio earthquakes, including border-region events, for the period 1983-1985.

near the location of two small earthquakes in 1981. A small earthquake also was recorded in 1985 in northern Fayette County.

Greenup County, Kentucky, in the Ohio border region, experienced a 3.7 Richter-magnitude earthquake in 1983 that was felt by many residents of Portsmouth in Scioto County. No damages were reported. This general region, the tri-state area of Ohio, Kentucky, and West Virginia, has been the site of several small earthquakes in recent years.

An additional border-region event occurred in Mercer County, Pennsylvania, just east of the Trumbull County, Ohio, line in 1983. This event had a Richter magnitude of 2.5; however, there were no reports from local residents of vibrations or other common earthquake phenomena. This earthquake was near the epicenter of a small earthquake in 1936.

—Michael C. Hansen

RECENT OHIO EARTHQUAKES

Date (UTC)[1]			Origin time (UTC)			Location			Richter magnitude
Yr	Mo	Day	Hr	Min	Sec	Lat. °N	Long. °W	County	
1983	01	12	02	49	41.1	39.28	84.60	Hamilton/Butler	2.0
1983	01	22	07	46	57.9	41.85	81.19	Lake (offshore)	2.7
1983	07	4	02	58	53.1	40.43	84.10	Shelby	2.0-2.2
1983	07	12	01	17	34.8	40.43	84.10	Shelby	1.2-1.5
1983	08	11	14	03	14.4	38.47	82.78	Greenup (Ky)	3.7
1983	09	30	02	33	44.8	41.59	84.33	Williams	1.2-1.4
1983	11	4	21	00	59.8	40.43	84.10	Shelby	0.3
1983	11	4	22	50	0.5	40.43	84.10	Shelby	0.7
1983	12	7	22	57	1.6	41.70	83.50	Lucas	2.0
1984	01	14	20	14	31.5	41.65	83.40	Lucas	2.6
1985	03	10	20	46	1.2	40.52	84.39	Auglaize	1.4
1985	03	10	20	49	14.1	40.52	84.40	Auglaize	1.7
1985	03	17	11	57	6.7	39.65	83.46	Fayette	1.9
1985	04	14	11	39	51.3	41.40	80.37	Mercer (Pa)	2.5
1985	08	25	16	27	11.9	40.97	84.22	Putnam	1.5

Source: Douglas Christensen, University of Michigan Seismological Observatory.

[1]UTC, Universal Coordinated Time, is equal to Greenwich Mean Time (GMT) and is used to standardize all earthquakes. To convert to local time (Eastern Standard Time) substract 5 hours (4 hours for Daylight Savings Time) from UTC. Note that events that occur in early morning hours on UTC are listed as a day later than local time.

FURTHER READING

Hansen, M. C., 1985, Earthquakes in Ohio: Ohio Geological Survey Educational Leaflet 9. Single copies available free of charge.

Hansen, M. C., Ohio earthquakes, including border-region events: Ohio Geological Survey Open-File Map 212, Scale 1:500,000. Map updated as needed. Diazo paper copies available for $5.50 plus tax and mailing.

USGS PUBLICATIONS AVAILABLE

A substantial supply of the U.S. Geological Survey publications listed below are available free of charge from the Ohio Survey. Mail orders should be accompanied by $1.00 for postage and handling.

Pepper, J. F., de Witt, Wallace, and Everhart, G. M., 1953, The "Clinton" sands in Canton, Dover, Massillon, and Navarre quadrangles, Ohio: U.S. Geological Survey Bulletin 1003-A, 13 p., 7 pls.

Schopf, J. M., and Schwietering, J. F., 1970, The *Foerstia* zone of the Ohio and Chattanooga Shales: U.S. Geological Survey Bulletin 1294-H, 15 p., 2 pls.

1984 MINERAL INDUSTRIES REPORT

The Survey has released the 1984 *Report on Ohio mineral industries,* compiled by Survey geologist and mineral statistician Margaret R. Sneeringer. The 1984 report provides production and employment statistics for all of Ohio's mineral industries, which include coal, limestone and dolomite, sand and gravel, sandstone and conglomerate, clay, shale, gypsum, salt, peat, and oil and gas. Statistics on mineral value and wages within each mineral-commodity group and directories of mineral producers in the state are included in the report.

The 1984 report contains many changes from the 1983 report. Additions include graphs of mineral sales and value, geographic location maps for each commodity, geologic and glacial maps of the state, and an alphabetical directory of industrial-mineral producers. Operators' telephone numbers and Division of Reclamation permit numbers are now included in the directories.

Single copies of the 1984 report are available from the Survey at no charge. Also available upon request are copies of the *Errata, revisions, and additions* for the 1983 *Report on Ohio mineral industries.* A summary of revised 1983 commodity information is given below. Please contact Sherry L. Weisgarber at 614-265-6588 for further information.

REVISED SUMMARY OF 1983 OHIO MINERAL STATISTICS

Numbers that are changes from those printed in the *1983 Report on Ohio mineral industries* are in *italics*

Commodity	Total production in 1983 (tons)	Total sales in 1983 (tons)	Value of tonnage sold (dollars)	Number of mines reporting sales	Average price/ton (dollars)
Coal	*33,306,626*	*33,696,990*	*$1,098,172,969*	313	*$32.59*
Limestone/dolomite	*25,847,358*	*31,552,828*	*105,773,341*	*125*[1]	*3.31*
Sand and gravel	*14,443,580*	*27,492,959*	*68,285,945*	*274*[1]	*2.76*
Salt	2,373,033	2,316,604	19,705,486	6	8.51
Sandstone/ conglomerate	837,445	1,509,447	18,683,030	33[1]	12.38
Clay	*695,416*	*815,063*	*4,947,670*	*36*[1]	*6.06*
Shale	*1,483,452*	*1,496,782*	*1,916,112*	*31*[1]	*1.28*
Gypsum	224,097	224,097	1,871,210	1	8.35
Peat	16,709	14,137	82,907	5	5.86

[1]Includes some mines which produced multiple commodities.

CORE RIG UPDATE

The Survey's Mobile B-61 Pacemaker core-drilling rig recently established a new depth record for a Survey core hole by successfully completing a core to Precambrian basement, at a site near Tiffin, Seneca County, to a depth of 2,870 feet. This core hole, drilled by Survey drillers Michael J. Mitchell and Roy T. Dawson, eclipsed the previous mark by 820 feet.

According to the rig's manufacturer, Mobile Drilling Company, this depth is also a new record for the B-61 rig using BCQ ($2^{3}/_{16}$ inch O.D.) drill rods. In addition, this core hole is thought to be the only continuous core in Ohio that goes from the surface to the Precambrian basement and for which there is a geophysical log to compare with the actual rock core. The Survey is in the process of preparing an Information Circular on this core hole.

—Douglas L. Crowell
Regional Geology Section

SURVEY STAFF NOTES

Carl Hopfinger

Sherry Weisgarber

Carl L. Hopfinger is a geology technician with the Lake Erie Section and has been with the Survey since 1978. Carl, who holds bachelor's and master's degrees in geology from the University of Toledo, has been involved in a variety of activities for the Survey including laboratory investigations, Lake Erie water-level recording, water-well locating, and assisting with the Lake Erie Section's research vessel, *GS-1,* and the Survey's core-drilling rig.

Carl lives in Port Clinton with his wife and two children. He particularly enjoys auto mechanics, swimming, and gardening as hobbies.

Sherry L. Weisgarber is a geologist and the Survey's new mineral statistician, responsible for compiling the annual *Report on Ohio mineral industries.* Sherry came to the Survey in 1984 after earning bachelor's and master's degrees in geology at Kent State University and a brief sojourn as an instructor of geophysics at Youngstown State University.

Sherry enjoys the "number crunching" aspects of her new position and learning about Ohio's mineral industries through personal contact with Ohio mineral producers. She is a native of Massillon and enjoys sports, caring for her houseplants, and reading.

SURVEY STAFF CHANGES

COMINGS

Mark T. Baranoski, Geologist, Subsurface Geology Section.
Michael R. Caudill, Geologist, Regional Geology Section.
Ronald A. Riley, Geologist, Subsurface Geology Section.
Douglas L. Shrake, Geologist, Regional Geology Section.

AND GOINGS

Philip V. Connors, Deputy Chief for Administration, to assistant director of personnel, Moller Steamship Company, Port Newark, New Jersey.
Brian E. O'Neill, Geologist, Regional Geology Section, to Houston, Texas.
Margaret R. Sneeringer, Geologist, Regional Geology Section, to Dublin, Ireland.

COAL-RESOURCE CLASSIFICATION SYSTEM

The Survey is frequently asked the question, "How much coal is left in Ohio?" In part, the answer depends upon the classification system employed to evaluate available data. A variety of classification systems have been used over the years, both nationally and in Ohio, and a new report recently issued by the Survey represents the latest attempt to further refine the methodology of coal-resource classification in the state.

This report, known as Open-File Report 85-1, was compiled by Survey geologist Douglas L. Crowell and is titled *Coal-resource classification system as used by the Ohio Department of Natural Resources, Division of Geological Survey*. The report consists of six pages of text plus one table and three figures. Single copies are available free of charge from the Survey.

QUARTERLY MINERAL SALES, APRIL—MAY—JUNE 1985

Compiled by Sherry L. Weisgarber

Commodity	Tonnage sold this quarter[1] (tons)	Number of mines reporting sales[1]	Value of tonnage sold[1] (dollars)
Coal	9,231,322	272	305,316,592
Limestone/dolomite[2]	9,633,074	95[3]	32,775,079
Sand and gravel[2]	7,941,011	211[3]	23,918,277
Salt[2]	817,544	5[4]	6,776,174
Sandstone/conglomerate[2]	607,528	23[3]	7,243,579
Clay[2]	249,808	26[3]	1,476,006
Shale[2]	323,991	16[3]	317,882
Gypsum[2]	62,620	1	594,892
Peat[2]	5,280	3	25,720

[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.

Ohio Department of Natural Resources
Division of Geological Survey
Fountain Square, Building B
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