FALL 1988

Ohio Geology Newsletter

Division of Geological Survey

COAL-MINE SUBSIDENCE IN OHIO

by Richard M. DeLong

For more than a century and a half, the underground mining of coal has been an active industry in eastern Ohio, which is underlain by coal-bearing rocks of Pennsylvanian age. During this long period, about 4,000 underground mines, ranging in size from a few acres to several square miles, have honeycombed the subsurface.

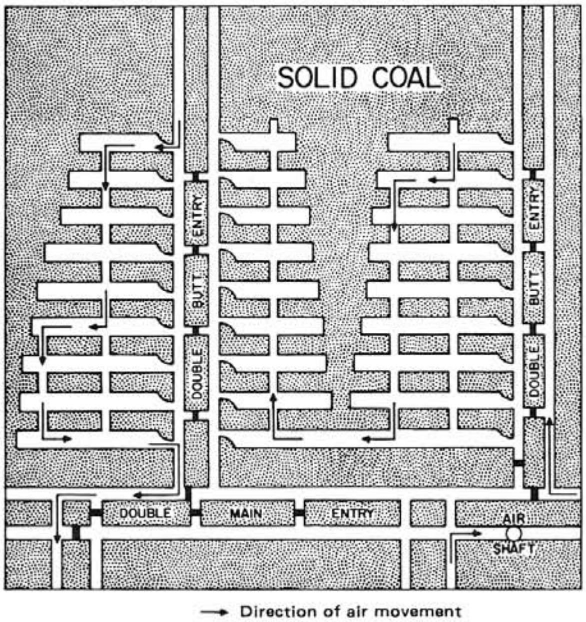
Several generations of coal mining have left us with both a tradition of mining and a legacy of abandoned mines from the "pick and shovel" era. Now, with an expanding population and its demand on space, the problems inherent in this legacy of abandoned underground mines are being realized.

Damage to a home near Canton, Stark County, caused by subsidence of a previously unrecorded abandoned underground coal mine. Photo courtesy of the Ohio Division of Reclamation.

One of the problems at the forefront is that of mine subsidence—caving or distortion of the ground surface due to collapse of underground mine workings. The cost of repairing damage to homes and other structures due to mine subsidence can total tens of thousands of dollars.

FACTORS IN MINE SUBSIDENCE

The susceptibility to subsidence of an area that overlies old workings is difficult to forecast, but consideration of some of the mining practices and the variable geologic factors gives some understanding of the complexity of prediction. The mining process begins by driving a main entry, which is at least a double tunnel, into the coal (see diagram). From the main entry, side entries are driven; from the side entries, areas called rooms are mined, with unmined coal in columns called pillars left between the rooms to support the mine. In addition to the pillars of coal, many mines used timbers to help support entries and passageways. It is from the rooms that the main coal production comes. This system of mining, aptly called "room and pillar," was with little exception universally practiced in Ohio.



Idealized double-entry room-and-pillar mine layout.

A major factor in subsidence to be considered is the amount of the coal that has been mined. Most mining operations of the 19th and early 20th centuries anticipated a recovery of 75 percent of the coal within a mine. In actual practice, however, because of geologic and mining conditions encountered, the recovery ranged from 40 percent to the anticipated 75 percent. The U.S. Geological Survey, in estimating reserves, considers 50 percent as the overall average amount of coal recoverable in underground mining. It is immediately obvious that the susceptibility to subsidence varies greatly depending on whether 60 percent or only 25 percent of the original coal is left in the ground. Furthermore, the distribution of the 25 to 60 percent of the coal left in the ground is not uniform throughout a mine.

ODNR
OHIO DEPARTMENT OF NATURAL RESOURCES

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

The first step in mining is gaining access to the coal. If the coal crops out on the hillside above drainage, it requires only a horizontal, or drift, entry into the seam. However, if the coal lies below stream level it must be reached either by a shaft, or vertical opening, or by a slope entry, an opening which angles downward 25° to 30° from the horizontal. Shafts present the greatest hazard from abandoned mines because collapse can be instantaneous with a drop of 100 feet or more. Air shafts to provide ventilation were commonly sunk, even in mines that were entered as a drift. Both air shafts and main or hoisting shafts are of considerable dimension, on the order of 8 feet by 16 feet in horizontal section and with depths ranging from tens of feet to over 400 feet. In Ohio, nearly 500 hoisting shafts and 2,000 air shafts are known to have been sunk. In the 19th and early 20th centuries there was no regulation for the closing of shafts and apparently some were left open while others were bridged across with timbers, which were then covered with dirt or in some cases with cement. Some shafts may have been filled in, at least to some extent. In some instances they were used as dumps. In any event, the method (if any) of closing them was not recorded.

Much coal was left in the ground at the entrance to the mine because ensuring that the passageways remain open was of paramount importance. Adequate support in these critical areas is essential or several events can happen that will result in the loss of the mine and also create subsidence at the surface. First, the floor of the mine must be considered. If the floor is the thick plastic clay that commonly underlies coal seams in Ohio, thin coal pillars may sink into the clay, lowering the roof of the mine near or to the floor. Miners refer to this as a "squeeze" or "creep." Conversely, a sandy, firm floor requires less support. Second, the coal itself is a factor in the amount of coal left as support pillars. Different coal seams have different crushing strengths, and those coals with weak crushing strength require larger pillars. When pillars break up from the pressure of the overlying strata (overburden), the roof of the mine is lowered to the floor, and the works must be closed. Miners term this a "crush." Third, the amount of overburden dictates the size of the pillars; the pillars progressively increase in size with increasing thickness of the overlying strata.

Entries generally were cut 8 to 10 feet wide; in thin seams the roof was cut as much as 6 feet high into the overburden to allow convenient passage. Rooms worked off the entries ranged up to 40 feet wide, and pillars left between rooms ranged up to nearly 20 feet wide. Commonly the pillars were later mined ("robbed" or "drawn") in retreat mining, leaving as little pillar as practicable for safety. In systems such as longwall or panel mining where large areas are depleted without support, collapse occurs quickly after mining. It is said that the collapse of the overlying rocks renders a noise "very peculiar, at one time loud and sharp, at another hollow and deep." Longwall mining has been rare in Ohio until recent years.

Whether or not mine subsidence occurs depends also on the character and thickness of the overburden. The total thickness, the strength of the overlying beds, and the occurrence of joint and fault planes are all factors determining if collapse will reach the surface. Coals in Ohio are generally overlain by shale, clay, sandstone, or limestone. Thick, competent (strong) beds such as massive sandstone or limestone may be able to bridge the gap of a mined-out void, whereas soft, jointed beds such as shale or clay tend to collapse.

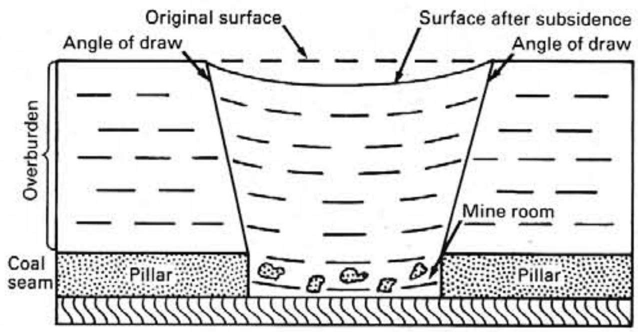
OHIO GEOLOGY

A newsletter published quarterly by the Ohio Department Natural Resources, Division of Geological Survey, Fountain Square, Columbus, Ohio 43224. Telephone (614) 265-6605 (Voice) or (614) 265-6994 (TTD).

Editor: Michael C. Hansen
Secretary: Donna M. Schrappe
Phototypist: Jean M. Lesher
Pasteup artist: Edward V. Kuehnle
Halftones: Robert L. Stewart

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.

Bridging of the void may be partial or complete, as the shattering and breaking of the overburden increases the volume of the rock. However, the increase in volume of material is reduced by compaction as the overlying beds collapse or sag owing to increased pressure, which, if sufficient, causes the shales and clays to deform and flow. Generally, the thicker the overburden the less likely the collapse will be reflected at the surface. Subsidence of the surface seldom equals the height of the void, and obviously a 3-foot void is more easily bridged than a 6-foot void; those mines with narrow rooms and wide pillars are more likely to span or bridge the voids. There is apparently no time limit for subsidence, nor "safe depth" for potential subsidence. Ironically, the areal extent of subsidence on the surface may be greater than the areal extent of the mined-out area, because as the collapse propagates upward it is inclined from the vertical plane by about 25° to 30°. The inclination of rupture, termed "angle of draw," varies with the thickness and character of the overburden. Subsidence and the angle of draw are illustrated in the accompanying cross section.



Diagrammatic cross section of an underground room-and-pillar mine illustrating collapse of the strata overlying a mined-out room and subsidence of the surface. Because of the angle of draw, the surface area affected by subsidence is larger than the area of the mine room.

Another suspected factor in subsidence is the eventual failure of timbers used for mine support. The time required for these failures probably varies from mine to mine, and there are no guidelines for prediction. The role of water in a flooded mine is uncertain. Apparently the presence of water is not in itself supportive, yet in some cases subsidence follows dewatering of a mine.

In considering the many variables controlling subsidence—the mining practices, the character of the mine floor, the thickness and character of the coal, and the thickness and character of the overburden—it is little wonder that subsidence is difficult to predict.

MITIGATION OF SUBSIDENCE DAMAGE

Mine subsidence is not a new phenomenon, but it has been relatively slow to be recognized as a problem in Ohio. However, since 1977, when Congress passed the Surface Mining Control and Reclamation Act, numerous occurrences of subsidence in Ohio have been documented. Through this act, administered by the U.S. Department of the Interior, Office of Surface Mining Reclamation and Enforcement (OSMRE), an Abandoned Mine Land Program, funded by a federal severance tax on coal, was established to investigate subsidence complaints and to provide immediate correction of mining-related subsidence that threatens life or property. A state severance tax on coal funds a state reclamation program. Homeowners can report known or suspected mine subsidence that may qualify for assistance directly to OSMRE (Columbus Field Office, 614-866-0578), to the Division of Reclamation in the Ohio Department of Natural Resources (614-265-6638), or to the local county disaster agency. In January 1989 the Ohio Division of Reclamation hopes to assume emergency-response duties on behalf of OSMRE. It must be noted that the Abandoned Mine Land Program can only reclaim lands affected by mines which were abandoned prior to August 1977.

Fortunately, Ohio has not yet had a loss of life because of mine subsidence, but Ohioans have suffered damages to buildings and roads. Between 1977 and 1987, $4 million have been spent to repair damages from mine-related subsidence. A common corrective practice is to grout the voids in and above the mine with cement. Mine subsidence has been reported to OSMRE from 18 counties in eastern Ohio within recent years, including 37 reports in 1987 alone. The list includes Athens, Belmont, Columbiana, Coshocton, Guernsey, Harrison, Jackson, Jefferson, Mahoning, Medina, Meigs, Muskingum, Noble, Perry, Stark, Summit, Trumbull, and Tuscarawas Counties.

The hazard of mine subsidence was dramatically brought to the attention of Ohio in 1977 at Youngstown. A cement cap to a then-unknown shaft for an underground mine was unsuspectingly being used as the floor of a garage. In the sudden collapse of the cap an unoccupied automobile fell 100 feet to the bottom of the shaft; total depth of the shaft was 230 feet. This incident illustrated the highly hazardous character of unfilled shafts compared to the less hazardous character of subsidence over mine workings where collapse does not exceed the height of the mine void, and in most cases as explained above, is considerably less. Slope entries, which generally were cut 10 feet wide and 6 feet high, are considered to be of medium hazard.

The accompanying photos contrast high- and low-hazard subsidence. Common indicators of gradual subsidence are cracks in masonry or pavement, jamming of doors and windows, and separation of porches or steps from structures. These symptoms, however, can also be produced by slumping unrelated to mines, poor foundations, changes in soil moisture, poor drainage around buildings, or removal of trees and shrubs. Sags resulting from defective field tile commonly have been misidentified as being mine related.

Shaft of the Wainright Mine, near Wellston, Jackson County. This 97-foot-deep, open, water-filled shaft has subsequently been filled with stone. Mine shafts such as this one may suddenly open when poor seals collapse. Photo courtesy of the Ohio Division of Reclamation.

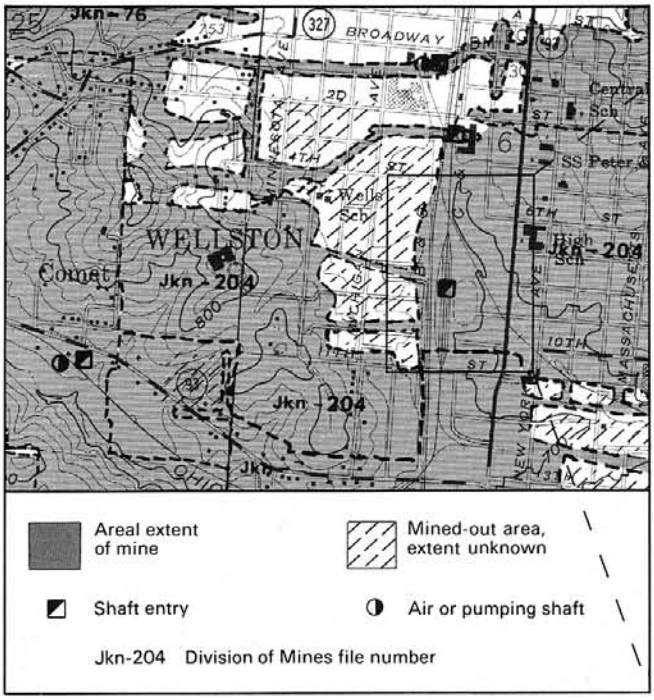
Effects of subsidence caused by collapse of strata above an abandoned underground mine in Youngstown, Mahoning County. Photo courtesy of the Ohio Division of Reclamation.

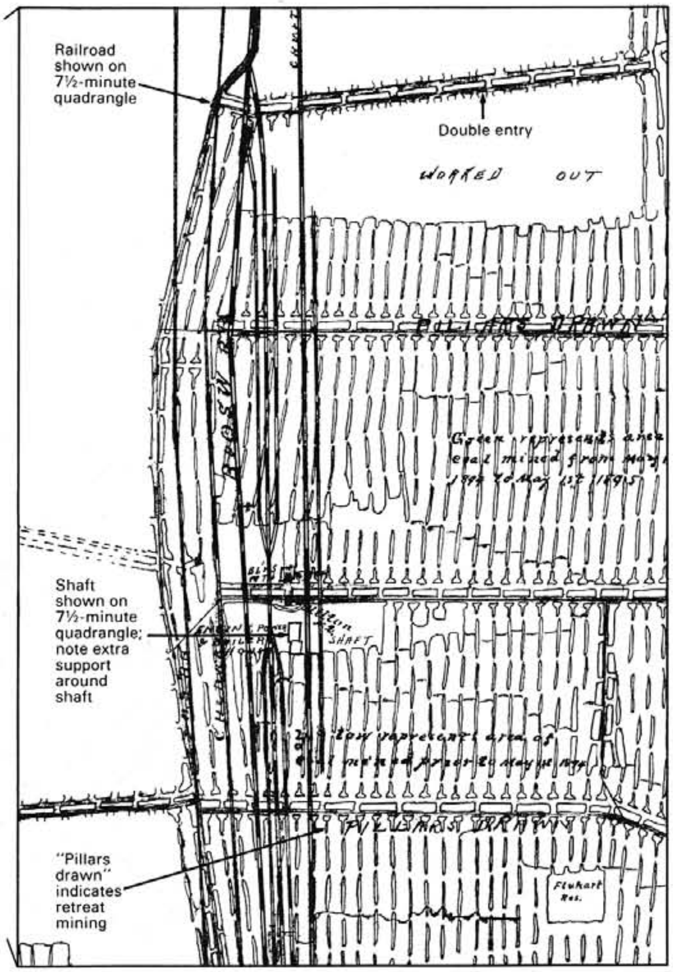
MINE SUBSIDENCE INSURANCE

Construction companies and developers in years past paid little if any regard to the presence of underground mines. As a means of protecting homeowners in the 36 counties in Ohio where underground mining has occurred, the Ohio Legislature in 1987 passed House Bill 383, which requires insurance agencies to offer to owners of structures housing one to four families a policy of up to $50,000 value against mine subsidence. Policy holders are notified of this offer upon notice of renewal of their insurance. Cost of this insurance is $20. For more information on mine subsidence insurance contact your insurance agent or the Ohio Mine Subsidence Underwriting Association, 6230 Busch Blvd., Suite 303, Columbus, Ohio 43229 (614-436-4530).

ABANDONED-UNDERGROUND-MINE MAPS

Despite the availability of insurance, a knowledge of the extent of mine workings and location of high-hazard shafts can be useful and reassuring. To that end, maps generated by the Division of Geological Survey can be helpful. These maps were prepared in cooperation with the Division of Mines of the Ohio Department of Industrial Relations with funding from the Ohio Division of Reclamation. In this cooperative effort the final abandonment maps for all mines on file at the Division of Mines were photographed and reduced to a





On the left is a portion of the Wellston (Jackson County), Ohio, 7½-minute quadrangle (scale 1:24,000) in the Division of Geological Survey's Abandoned-underground-mine map series *showing the extent of mining (screen pattern), locations of shafts, and other mine-related features. On the right is a portion of one of the individual mine maps (scale 1:4,800) used to compile the information on the quadrangle. The mine map is of the Milton Coal Co. No. 1 and No. 2 mines, labelled as Jkn-204 on the quadrangle, and shows the rooms, pillars, shafts, and entries. The Milton No. 1 and No. 2 mines, which were abandoned about 1902, underlie much of the city of Wellston and have contributed to subsidence problems in this community. The overburden above these mines ranges from about 40 to 160 feet thick. The open areas at the top and on the left side of the mine map are worked-out areas where the extent of mining is unknown. The area in the lower right labelled "Fluhart res." was left unmined in order to support the area around the home of the Fluharts.*

common scale of 1:4,800 (1 inch equals 400 feet). The maps of the individual mines were further reduced to a scale of 1:24,000 (1 inch equals 2,000 feet), and their location and extent and all entries (drift, shaft, or slope) and air and pumping shafts were plotted on mylar bases of U.S. Geological Survey 7½-minute series topographic maps. Known openings for which there is no map also are plotted on these mylar bases. In the region of the Sharon (No. 1) coal field in the Youngstown area, the Division of Geological Survey has made a special effort to locate and catalog mine shafts because of their high-hazard character. The 189 quadrangles which have mines plotted constitute the *Abandoned-underground-mine map series.*

A series of county index maps also has been produced by photographically reducing the quadrangle maps and compiling them at a scale of 1:62,500 (1 inch equals approximately 1 mile). Paper copies of all of the maps described above are available from the Survey. The quadrangle maps (1:24,000) and county index maps (1:62,500) are $4.00 each ($5.47 total, including tax and mailing); maps of the individual mines range from $2.00 to $4.00 each (plus tax and mailing) except for some oversized maps, which are priced individually. For information on which counties and quadrangles have abandoned-underground-mine maps available contact the Division of Geological Survey at 614-265-6595.

ODNR CALENDAR AVAILABLE

The 1989 Ohio Department of Natural Resources calendar is now available. The 13-month calendar is highlighted by 14 color photographs of natural features in Ohio. Important ODNR events are listed for each month and a separate section lists Ohio's state forests, nature preserves, state parks, public boating areas, public hunting and fishing areas, and ODNR district offices. These listings include locations, available facilities, and other information. The calendar is available by mail for $3.87, which includes tax and mailing, from the Publications Center, Ohio Department of Natural Resources, Fountain Square, Building B, Columbus, OH 43224.

DEVONIAN SHALE GAS IN LAWRENCE COUNTY

The Survey recently released Open-File Report 88-2, *Analysis of stratigraphic and production relationships of Devonian-shale gas reservoirs in Lawrence County, Ohio.* The report was authored by Survey geologists Mark T. Baranoski and Ronald A. Riley.

This report was prepared as part of a Survey study of structural and stratigraphic relationships of oil and gas production from Devonian shale wells in southeastern Ohio. The study is funded by the Gas Research Institute of Chicago. Open-File Report 88-2 is available from the Survey for $2.86, which includes tax and mailing.

RICHARD M. DELONG RETIRES

The Survey, and the people who make it a viable organization, are always in a state of flux, but within the professional memories of the entire staff Richard M. DeLong has always been one individual who has provided continuity of past and present. However, this circumstance has changed. On July 31, 1988, Dick retired after 34 years of continuous service to the Survey and its constituency. Dick's length of employment with the Survey ties him with Wilber Stout for the longest continuous service of a geologist with this organization.

Richard M. DeLong

Dick DeLong was born and grew up in Marion County. After service in the South Pacific in World War II, Dick obtained a bachelor's degree in geology from Ohio Wesleyan University in 1950. He then began graduate studies at Ohio State University and obtained a master's degree in geology in late 1951. Dick's thesis was on the Sharon sandstone and associated rocks in a portion of Jackson County. After graduation, he worked for Carter Oil Company for two years, spending time on wells in Wyoming and Illinois.

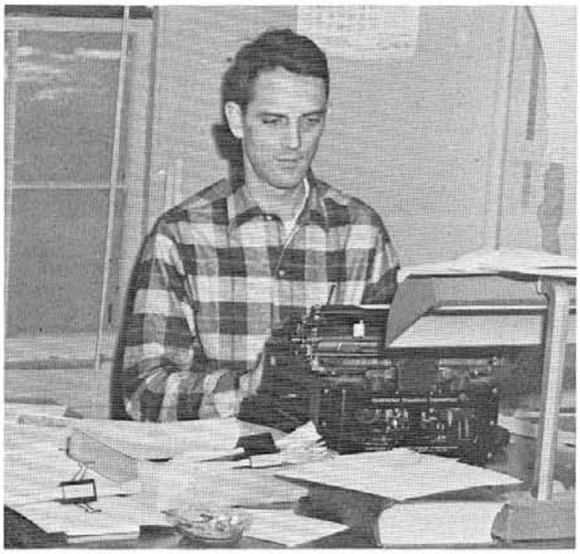
Dick began his career with the Survey in 1954, and he has served under three State Geologists—John H. Melvin, Ralph J. Bernhagen, and Horace R. Collins. His first assignments with the Survey were focused on coal resources and Pennsylvanian rocks. Dick devoted his entire career to these endeavors, and his expertise on coal and coal-bearing rocks of Ohio was a continual source of benefit to the Survey and to the many individuals who sought such information.

During his long tenure at the Survey, Dick published 11 Reports of Investigations. These publications dealt with coal resources or the geology of various quadrangles. He also coauthored two major bulletins, *Geology of Stark County* (with George W. White), and *Coal resources of Ohio* (with Russell A. Brant). Dick has also completed a major map and manuscript on the geology of Harrison County, which awaits publication.

A major segment of Dick's time for the last several years was devoted to the *Abandoned-underground-mine map series*. This series of 189 maps depicts the location and extent of thousands of abandoned underground mines in the state. This information is plotted on mylar copies of U.S. Geological Survey 7½-minute quadrangle maps and was compiled from original mine maps on file at the Division of Mines of the Ohio Department of Industrial Relations. This was a massive project, but it was worth the intense effort put forth by Dick DeLong because the abandoned-mine maps have been used by many citizens, industry people, and governmental agencies.

Perhaps the most popular publications produced by Dick were Report of Investigations No. 63, *Geology of the South Bloomingville quadrangle*, and Report of Investigations No. 84, *Geology of the Flint Ridge area*. The former report deals with the geology of the Hocking Hills region. Both maps include a popularized explanation of the geology and historical aspects of these tourist areas.

Dick DeLong has seen the Survey grow and change during 34 years and has experienced many of the inevitable "boom and bust" budgetary and program cycles. He has also witnessed great changes in the science of geology. In particular, Dick recalls the great changes in concepts of sedimentology and the evolution of new ways to interpret the depositional environments and stratigraphy of coal-bearing rocks. And, of course, Dick has witnessed and taken great interest in the development of plate tectonics theory and the consequent changes in the way we interpret the history of the Earth.



Dick DeLong hard at work in 1962

Dick DeLong will be missed professionally and personally at the Survey, both by staff and by the many constituents who visited our offices for information on coal and counted on Dick to provide the data they needed. At his retirement dinner on August 17, 1988, Dick related to his many friends and colleagues in attendance that he had been receiving telephone calls at home after his retirement from individuals wanting coal information. Even though the maps and reports are filed at the Survey, these individuals wanted only Dick to interpret them.

Dick plans to now spend time with his grandson and perhaps do a bit of "gentlemanly geology" along with travel with his wife. All of his friends and colleagues wish him well in his new ventures. We will forever be grateful for the legacy of geologic data he leaves behind from which we and future geologists and Ohio citizens will continue to benefit.

—Michael C. Hansen

STRATIGRAPHIC SECTION FILE

The Division of Geological Survey maintains an extensive file of measured stratigraphic-section descriptions of Ohio's rocks and glacial sediments. These sections, some of which date to the Second Geological Survey of Ohio under J. S. Newberry in the 1870's, number nearly 18,000. They represent surface exposures of rocks and sediments in all parts of the state, although measured sections of bedrock exposures are most abundant for eastern Ohio counties.

Each stratigraphic section has been given a unique file number (commonly referred to as an OGS number) which is recorded in a master file book and on the appropriate 15-minute quadrangle map at the location where the section was measured. More recent sections also are located on 7½-minute quadrangle maps. As part of an ongoing process, some locations have been transferred from the 15-minute maps to the 7½-minute maps. Each section description is filed by county and township. This file and the location maps are available for public inspection in the Regional Geology Section of the Survey.

Although there is considerable variance in accuracy and detail among the sections in the file, these data serve as a permanent record of the rocks or sediments noted by an observer at a particular place at a particular time. Many sections in the file were measured at locations where the section of rock is no longer exposed. Such sections are invaluable records for all present and future investigations of Ohio's geology.

The Survey encourages researchers, including graduate students, in Ohio geology to place copies of published or unpublished stratigraphic sections measured in the state in the Survey's stratigraphic section file. Such sections will be assigned a unique file number which can serve as a handy reference number in publications. The sections will then be available to other researchers through on-site inspection at the Survey or by mail order (with a nominal charge for photocopying and mailing). Please contact the Regional Geology Section of the Division of Geological Survey (telephone: 614-265-6597) to order sections or place sections in the file.

1987 REPORT ON OHIO MINERAL INDUSTRIES

The *1987 Report on Ohio mineral industries*, compiled by Survey geologist and mineral statistician Sherry W. Lopez, will be available in the late fall. The 1987 report provides production, sales, and employment statistics for all Ohio mineral industries, including coal, limestone/dolomite, sand/gravel, sandstone/conglomerate, clay, shale, gypsum, salt, and peat, plus production and mineral-value statistics for oil and gas. Alphabetical and by-county directories of coal and industrial-mineral mine operators also are included, as is a map of the locations of reporting producing coal mines and all industrial-mineral mines in 1987. Contributed articles this year are on coal-ash utilization, petrographic prediction of pyritic sulfur reduction, and critical mineral resource zoning.

For 1987, data reported to the Division of Geological Survey indicate that coal production decreased 4.6 percent from 1986, totalling 33,152,316 tons in 1987, with Belmont County leading in production. Total tonnage sold decreased 4.5 percent from 1986, to 33,321,936 tons. Coal's total value of $1,004,155,255 made it the most valuable mineral resource produced in Ohio. Total industrial mineral sales increased 13.0 percent from 1986, to 93,614,799 tons, with a total value of $363,440,856. Sales of all industrial mineral commodities increased with the exception of salt. Sandusky County led in sales of limestone and dolomite, Hamilton County led in sales of sand and gravel, Geauga County led in sales of sandstone and conglomerate, Tuscarawas County led in sales of clay and shale, Cuyahoga County led in sales of salt, Champaign County led in sales of peat, and gypsum was sold only in Ottawa County. Crude oil production decreased 10 percent from 1986, to 12,152,567 barrels. The value of the crude oil produced was $211,876,772. Natural gas production decreased 8.5 percent from 1986, to 166,592,553 MCF. The five most active counties for 1987 drilling activity were Tuscarawas, Summit, Coshocton, Mahoning, and Washington Counties. The gas produced was valued at $425,702,897. The total market value for Ohio's oil and gas production in 1987 was $637,579,669.

This information plus more is included in the *1987 Report on Ohio mineral industries*. Single copies of the 1987 report and map are available from the Survey for $6.53, which includes tax and mailing. The map is available separately for $1.81, which includes tax and mailing. To obtain the report, contact Mrs. Lopez at ODNR, Division of Geological Survey, Fountain Square, B-2, Columbus, OH 43224, telephone 614-265-6588. Also available upon request are copies of the *Errata, revisions, and additions* for the *1986 Report on Ohio mineral industries*. A summary of the revised 1986 commodity information is given below.

REVISED SUMMARY OF 1986 OHIO MINERAL STATISTICS

Numbers that are changes from those printed in the *1986 Report on Ohio mineral industries* are in *italics*

Commodity	Total production in 1986 (tons)	Total sales in 1986 (tons)	Value of tonnage sold (dollars)	Number of mines reporting sales	Average price/ton (dollars)
Coal	*35,212,175*	*35,376,159*	*$1,114,007,331*	*311*	*$31.49*
Limestone/dolomite	*42,669,149*	*42,481,408*	*155,301,350*	115[1]	*3.66*
Sand and gravel	*37,615,369*	*36,357,917*	*114,539,920*	*259*[1]	*3.15*
Salt	4,343,397	3,885,824	40,890,030	5	10.52
Sandstone/ conglomerate	*2,082,762*	*1,924,258*	*24,854,611*	*26*[1]	*12.92*
Clay	*1,139,292*	*1,140,695*	*6,194,908*	33[1]	*5.43*
Shale	*1,542,724*	*1,584,072*	*1,842,873*	24[1]	*1.16*
Gypsum	213,972	213,972	2,032,736	1	9.50
Peat	11,162	17,184	101,544	3	5.91

[1]Includes some mines which produced multiple commodities.

FEDERAL MINERAL AND EARTH SCIENCE INFORMATION CENTER

The U.S. Geological Survey and the U.S. Bureau of Mines have entered into a cooperative venture by establishing a Minerals Information Office in Washington, D.C. The purpose of the new office is to provide easy public access to geologic, geophysical, hydrologic, and cartographic information.

The Minerals Information Office is located adjacent to the USGS Earth Science Information Center, at 18th and E Streets, N.W., Washington, D.C. 20240 (telephone: 202-343-5512). Both agencies maintain access to a wide variety of staff experts and publications on various aspects of mineral-resource information.

OHIO MINERAL INDUSTRIES WORKSHOP IS AGAIN A SUCCESS

What mineral resources are mined in Ohio? That and many more questions on Ohio's mineral resources were answered during the second Ohio's Mineral Industries Workshop. The teachers' workshop was conducted by the Division of Geological Survey and the University of Akron June 27-July 1 at the ODNR Fountain Square complex in Columbus. Grants from the Ohio Aggregates Association, Ohio Mining and Reclamation Association, Ohio Oil and Gas Association, and Ohio Coal and Energy Association paid for field-trip costs and educational materials.

The purpose of the workshop was to familiarize participants with the geology of Ohio and the development of mineral industries in the state so that the teachers could more effectively communicate this information to their students. The 14 junior and senior high school teachers heard representatives from research, industry, and regulatory agencies present a variety of information on the economics, regulations, and geologic origin of mineral resources in the state.

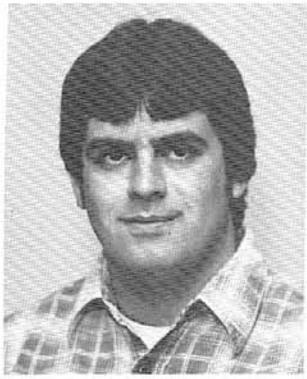
Three days of field trips gave the teachers a firsthand look at the operations of various mineral industries. The first field trip, which included an overnight stay at Burr Oak Lodge in Morgan County, visited Waterloo Coal Company in Jackson County. Teachers viewed coal strip mining, reclamation activities, and limestone and clay mining. Lunch was provided by Waterloo Coal Company. Afternoon activities included a tour of Buckeye Furnace, a reconstructed charcoal-iron furnace that operated in the 1800's in Jackson County. The tour included a slide presentation which described the historic mining and production technologies used at the time. The last activity of the first day was a tour of Southern Ohio Coal Company's coal-preparation plant in Meigs County, which is the largest coal-preparation plant in North America. On the second day of the field trip the teachers visited a working oil and gas pump and storage tank in Perry County, where they learned the mechanics of drilling for oil and gas and many concerns of the industry. The group then toured Central Silica Company's sandstone quarry and glass-sand processing plant in Perry County. Lunch was provided by Central Silica Company. The day ended with a tour of the brick plant and shale pit of Bowerston Shale Company in Licking County.

The second field trip was in Franklin County. The teachers toured several operations of the American Aggregates Corporation, including their testing laboratory, Columbus Limestone Quarry, Frank Rd. Sand and Gravel Pit, and Marble Cliff Limestone Quarry. Workshop participants also visited Anderson Concrete Corporation's portland-cement concrete-mixing plant, the Franklin County Sanitary Landfill, and several reclaimed sand and gravel pits and limestone quarries.

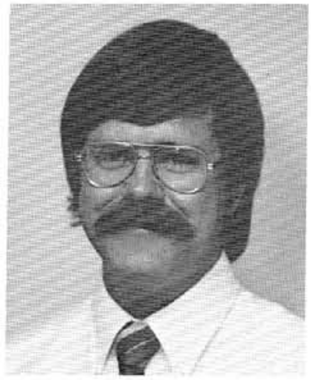
Many favorable comments, both written and oral, were received regarding the workshop, indicating that it was a very informative and successful five days. One teacher on the last day said, "I never thought very highly of Ohio's mineral industries until now." That was our intent, to open the eyes of the teachers, and therefore their students, to Ohio's mineral resources and the responsible way in which they are being extracted. We hope that next year's workshop will be as successful as this year's. Details regarding the 1989 Ohio's Mineral Industries Workshop will be included in the winter issue of *Ohio Geology.*

—Sherry W. Lopez and René L. Fernandez

SURVEY STAFF NOTES



Roy T. Dawson



Richard R. Pavey

Roy Dawson is in charge of operating the Survey's Mobile B-61 core-drilling rig. Roy came to the Survey in 1984 after working for three years as a driller and equipment operator in the coal industry in Perry County. He enjoys the mechanical challenges of running the B-61 rig and the opportunity to be outdoors.

Roy is originally from Junction City in Perry County and now lives at Buckeye Lake, east of Columbus, with his wife and two children. He enjoys hunting and fishing as hobbies.

Rick Pavey is a geologist in the Regional Geology Section and Coordinator of the Pleistocene Mapping Subsection. Rick came to the Survey in 1984 after completing bachelor's and master's degrees in geology at Purdue University and working for an engineering firm in Indiana. He enjoys field work for the Survey and the excitement of making new discoveries about the glacial geology of Ohio.

Rick is originally from Anderson, Indiana, and now lives in the Columbus suburb of Worthington with his wife and child. Rick enjoys camping and woodworking as hobbies.

GLACIAL GEOLOGY OF GEAUGA COUNTY

Report of Investigations No. 140, *Glacial geology of Geauga County, Ohio,* by Stanley M. Totten, was recently released by the Survey. The report on this northeastern Ohio county consists of a 30-page book and a color map at a scale of 1:62,500.

The map depicts the distribution of Wisconsinan-age glacial deposits exposed at the surface in Geauga County. These deposits are catagorized as to their origin (ground moraine, end moraine, kame, outwash, etc.) and, in the case of tills, are assigned to specific units. Contours on the bedrock surface also are depicted on the map.

The book discusses the physiography, Pleistocene and modern drainage, various glacial deposits and their stratigraphy, mineral resources, and environmental and engineering geology. Included in the report are page-size maps of bedrock geology, physiographic divisions, drift thickness, modern drainage, preglacial and early Pleistocene drainage, and soil associations.

The report on Geauga County will be of great value to those concerned with land-use planning, builders, engineers, well drillers, sand and gravel pit operators, and individuals interested in or concerned with the characteristics of the surface deposits in the county. Report of Investigations No. 140 is available from the Survey for $15.44, which includes tax and mailing.

ANALYSES OF OHIO COALS

The Survey recently released Information Circular No. 55, *Analyses of Ohio coals, 1982-1984,* by staff geologists George Botoman and David A. Stith. This report is the fourth in a series on the geochemistry of Ohio coals and is the result of an informal cooperative effort of the Division of Geological Survey and the U.S. Geological Survey.

A total of 109 samples were subjected to standard coal analyses (proximate and ultimate) and were analyzed for 72 major, minor, and trace elements. Sixteen additional samples were analyzed for major, minor, and trace elements only. Samples were collected from active surface mines and from Division of Geological Survey cores in the following counties: Belmont, Carroll, Columbiana, Gallia, Guernsey, Harrison, Jackson, Jefferson, Muskingum, Stark, Tuscarawas, and Vinton. The samples represent 16 separate coal beds.

Information Circular No. 55 consists of a 17-page book that contains tables listing results of standard analyses by county and by coal bed and four separate tables that list major, minor, and trace element content of whole-coal samples and laboratory-ash samples by county and by bed. This report is available from the Survey for $5.47, which includes tax and mailing.

QUARTERLY MINERAL SALES, JANUARY—FEBRUARY—MARCH 1988

compiled by Sherry W. Lopez

Commodity	Tonnage sold this quarter[1]	Number of mines reporting sales[1]	Value of tonnage sold[1] (dollars)
Coal	8,127,456	208	259,701,945
Limestone/dolomite[2]	6,362,749	99[3]	23,409,990
Sand and gravel[2]	4,187,212	185[3]	13,902,085
Salt	1,372,919	5[4]	14,150,480
Sandstone/conglomerate[2]	368,365	23[3]	6,598,404
Clay[2]	426,211	24[3]	770,541
Shale[2]	223,788	18[3]	597,217
Gypsum[2]	58,906	1	380,533
Peat	959	2	4,650

[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.

QUARTERLY MINERAL SALES, APRIL—MAY—JUNE 1988

compiled by Sherry W. Lopez

Commodity	Tonnage sold this quarter[1]	Number of mines reporting sales[1]	Value of tonnage sold[1] (dollars)
Coal	6,981,590	211	223,880,064
Limestone/dolomite[2]	12,035,928	93[3]	43,417,681
Sand and gravel[2]	11,629,347	202[3]	36,146,048
Salt	482,962	5[4]	5,193,497
Sandstone/conglomerate[2]	488,459	25[3]	8,466,448
Clay[2]	594,270	30[3]	950,740
Shale[2]	917,938	19[3]	1,395,027
Gypsum[2]	59,139	1	382,038
Peat	5,576	4	28,374

[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
Columbus, Ohio 43224

OHIO DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGICAL SURVEY

Naturally OHIO the heart of it all!

BULK RATE
U.S. POSTAGE PAID
Columbus, OH
Permit No. 537

TOTAL COPIES PRINTED
UNIT COST
PUBLICATION DATE 12/88