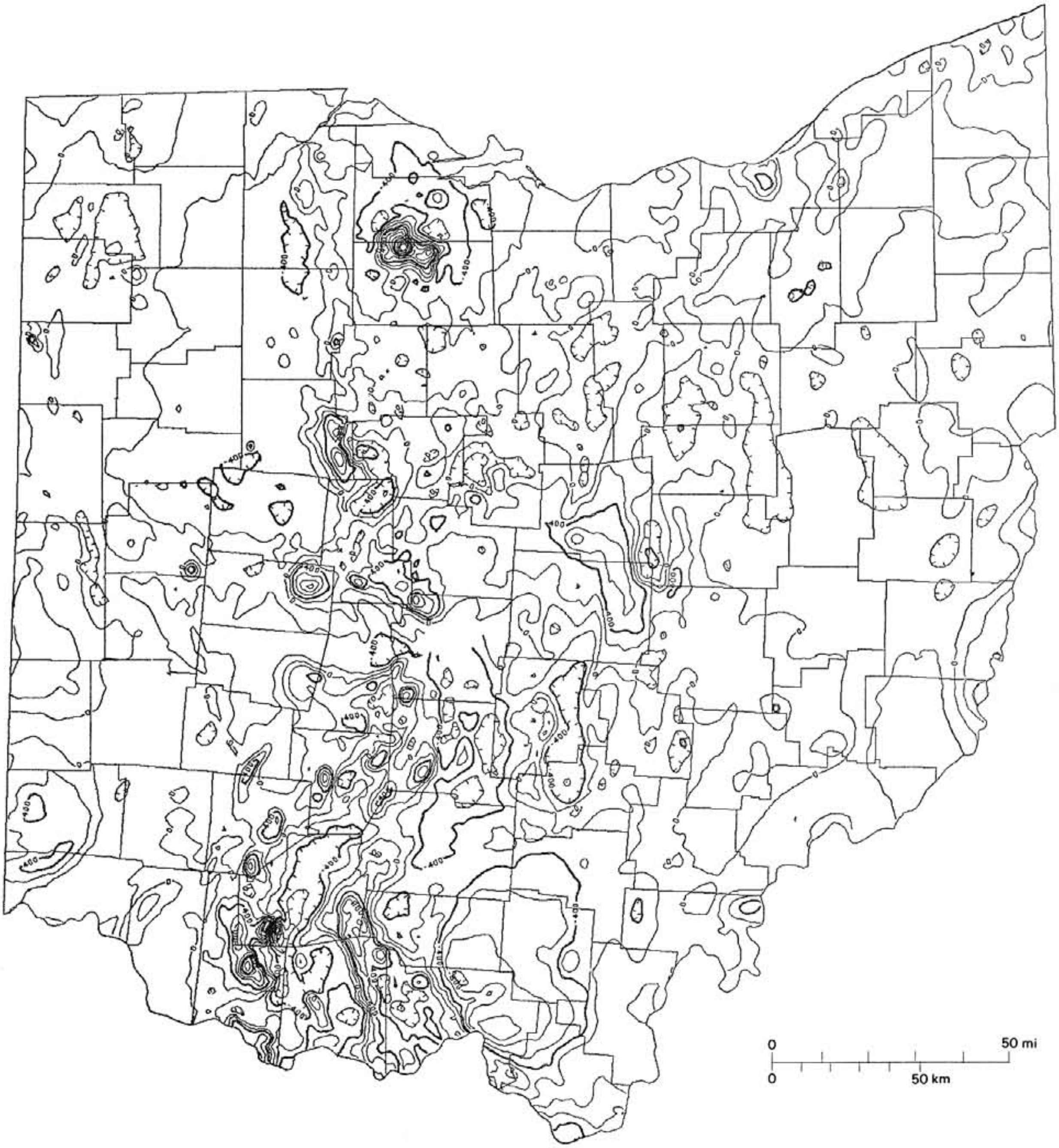
SUMMER 1984

Ohio Geology Newsletter

Division of Geological Survey

THE AEROMAGNETIC MAP OF OHIO



OHIO DEPARTMENT OF NATURAL RESOURCES

Richard F. Celeste, Governor • Lt. Gov. Myrl H. Shoemaker, Director

Chief's corner

by Horace R. Collins

An article in the Winter 1983 issue of *Ohio Geology* discussed coal-resource classifications and the question of how much coal is left in Ohio. It was pointed out that one serious problem with arriving at a reliable estimate is that people tend to not be precise in their definition. This tendency is an example of the popular "apples and oranges syndrome." Apart from the confusion of semantics, the lack of an adequate estimate of how much coal is available for the entire state is a serious matter.

It is important to know how much mineable coal there is in the state for various reasons. Coal plays a major part in our industrial society and considerable public dollars are spent on regulating, taxing, and promoting coal. Some say we have so much coal that there's no need to worry about it or to spend tax dollars to gather facts on coal. Others say there really isn't that much coal left and we'll be out of it relatively soon so let's not worry about it. Neither of these positions is good for those who mine coal, who use coal, or whose economic well-being is related to the production and use of coal. Nor is either position helpful to those who must formulate public policy. Clearly, public policy must be founded on accurate data if it is to receive widely based support.

To promote wise, efficient, and environmentally safe use of Ohio coal we must know with a reasonable degree of reliability how much coal is available for development. Not only must we know how much coal is left but we must know where the coal is, how deep it is, and what its chemical characteristics are. We must also know how the local geology will affect considerations ranging from reclamation of mining sites and protection of surface and ground water to development of safe mining plans and techniques to protect the health and life of miners.

The Division of Geological Survey has made much headway in recent years in addressing not only the question of how much coal Ohio has but also many other questions for which answers are needed. The Geological Mapping Program will provide detailed information on shallow resources and on the local geology of coal-bearing counties. The Survey's core-drilling program is adding new information on deep coal in areas for which no data were previously available. The Abandoned-Underground-Mine Map Series shows those areas from which deep coal has already been mined. Other programs are adding detailed chemical analyses and coal-washing data.

However, we are still a long way from having a complete estimate of coal reserves for each coal-bearing county. Ohio and the nation are at a critical juncture and it is important that society understand what options really exist regarding our future energy supplies. Nor should we forget that coal is also an extremely valuable raw material for conversion into hundreds of products, such as aspirin and gasoline, which are needed in our everyday life. It is important therefore that the Survey complete the task of gathering, analyzing, and integrating coal-resource data so that informed decisions can be made at all levels regarding Ohio's most valuable mineral resource.

NEW ODNR CALENDAR AVAILABLE

The Ohio Department of Natural Resources calendar for 1985 is now available from the Survey for $1.81 (includes tax and mailing).

OHIO GEOLOGY

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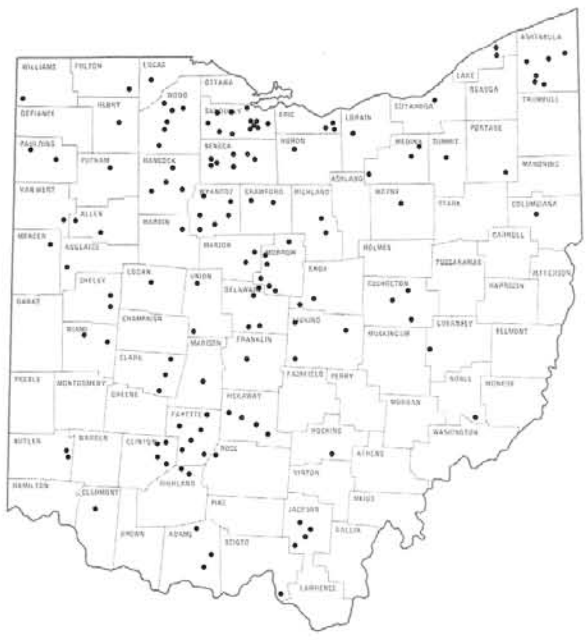
News items, notices of meetings, etc. should be addressed to the attention of the editor. Change of address and new subscriptions should be addressed to the attention of the secretary.

"JOURNEY TO THE CENTER OF THE EARTH"—THE AEROMAGNETIC ANOMALY MAP OF OHIO

The crystalline igneous and metamorphic rocks that underlie Ohio are far from the center of the earth, but our previous knowledge of them has been nearly as speculative as a Jules Verne novel. Edward Orton Sr., third State Geologist of Ohio, suggested in 1890 that "If we should descend deep enough below the surface we should reach the limit of these stratified deposits [Paleozoic sedimentary rocks] and come to the great foundations of the continent which constitute the surface rocks in parts of Canada, New England and the West. The granite of Plymouth Rock underlies the continent." It was not until 1912, however, that a well drilled in Marion Township, Hancock County, struck crystalline rocks for the first time in Ohio, at a depth of 2,770 feet. Ironically, this well penetrated granitic rocks, seemingly confirming Orton's hypothesis of Plymouth Rock continuing beneath the continent.



Distribution of oil and gas wells reported to have penetrated basement rocks.

A total of 138 wells have now been drilled into the crystalline basement rocks in Ohio—a large number in comparison to adjoining states—and from these data we have learned that most of the crystalline igneous and metamorphic rocks are of Precambrian age, most likely having reached their present form between 1.5 and 0.8 billion years ago. We have also learned that these rocks are not all similar to Plymouth Rock; indeed, they are highly variable. Depths to the igneous and metamorphic rocks range from about 3,000 feet in western Ohio to more than 12,000 feet in the eastern part of the state. They are everywhere covered by a thick blanket of sedimentary rocks of Paleozoic age. The terms "basement," "basement complex," "granite," and "Precambrian" have been used informally and interchangeably by geologists for the crystalline igneous and metamorphic rocks.

Although our knowledge of the basement rocks of Ohio has progressed greatly since the days of Orton, our understanding of them is probably more confusing than enlightening. Indeed, the basement rocks can truly be considered the last geological frontier in Ohio. This circumstance is beginning to change dramatically, however, with the recent publication of an aeromagnetic anomaly map for Ohio (Hildenbrand and Kucks, 1984; see description at end of this article), a cooperative project of the Ohio Geological Survey and the U.S. Geological Survey. This map, portrayed in a reduced and simplified version on the cover of this issue of *Ohio Geology*, reveals a complexity in the basement rocks that was unexpected by most geologists. It offers an opportunity for new and provocative interpretations of the geologic history of the state and may serve as a guide to potential new sources of hydrocarbons (oil and gas) in overlying rocks and perhaps also to deposits of metallic minerals.

The aeromagnetic anomaly map of Ohio and other maps to be published later this year will give Ohio the most comprehensive package of publicly available geophysical maps of any state in the country. Such a data base has the potential to create a new chapter in Ohio geology and mineral exploration.

MAGNETIC ANOMALY MAPS

Magnetic anomaly maps depict the variation in magnetic properties of the basement rocks; these variations in general are related to the relative amount of magnetic minerals, particularly magnetite, that they contain. Sedimentary rocks, which overlie the basement rocks in Ohio, commonly contain such a small amount of these minerals that they have little or no influence on the magnetic anomaly pattern of an area. Thus, an aeromagnetic anomaly map portrays the contrasting rock types (lithologies) and structural trends of the crystalline rocks in the crust from the base of the sedimentary rock cover to the depth at which the rocks lose their magnetic properties owing to temperature increase (known as the Curie-point geotherm).

Aeromagnetic anomaly data are obtained by a precision instrument, most commonly a proton precession magnetometer, attached to an aircraft that flies a precisely determined route at a prescribed altitude. Inside the aircraft are instruments that continuously record the magnetic readings picked up by the magnetometer as the plane flies in a gridlike network over a particular area. The spacing of the grid lines for the aeromagnetic anomaly map of Ohio range from 1 to 2 miles, except for Lake Erie, where shipborne data were collected along tracks with a 6-mile spacing.

The commonly used unit of measurement of the magnetic-field strength or intensity is the gamma. By subtracting the value of the earth's magnetic field and the residual values at prescribed intervals, a contour map of the magnetic intensity can be prepared. These magnetic maps resemble the familiar topographic-contour maps; however, the "hills" and "depressions" on the magnetic map are not necessarily coincident with any topographic relief on the surface of the basement rocks. The hills are magnetic highs, that is, areas of rock with a relatively high concentration of magnetic minerals, whereas the depressions are areas with rocks of relatively low concentrations of magnetic minerals.

Circular-shaped closures of magnetic contour lines indicate a contact between magnetically contrasting rock types, commonly a pluton intruded into rocks of differing magnetic properties. Generally, magnetic lows are associated with light-colored rocks, such as granite, that contain a relatively small amount of magnetite, whereas magnetic highs are commonly associated with dark-colored rocks with high magnetite content such as basalt, anorthosite, and gabbro.

Magnetic data are also useful in preparation of maps of the basement surface, that is, a topographic map of the basement surface as if all overlying sedimentary rocks had been removed. Such maps utilize control points from wells drilled into the basement and can be accurate to within 5 to 10 percent of the true depth to basement. In addition, by comparing basement-rock types from deep oil and gas wells with areas of similar magnetic signature, geologists can make cautious extrapolation as to the rock types present in areas where no well data exist.

Ohio is particularly suited to such studies, in comparison to surrounding states, because of the large number of wells in the state that penetrate basement rocks. Indeed, Ohio has several times the number of wells drilled to basement rocks as any surrounding state, although the number of wells is still quite small in comparison to the area, averaging only one well per 300 square miles.

THE BASEMENT OF OHIO

The sum of information available about the crystalline rocks beneath Ohio is many times less than for any other geologic system present in the state. Obviously, this dearth of information is because these rocks are nowhere known to be exposed at the surface in Ohio and they lie well below oil- and gas-bearing horizons commonly tested by drilling.

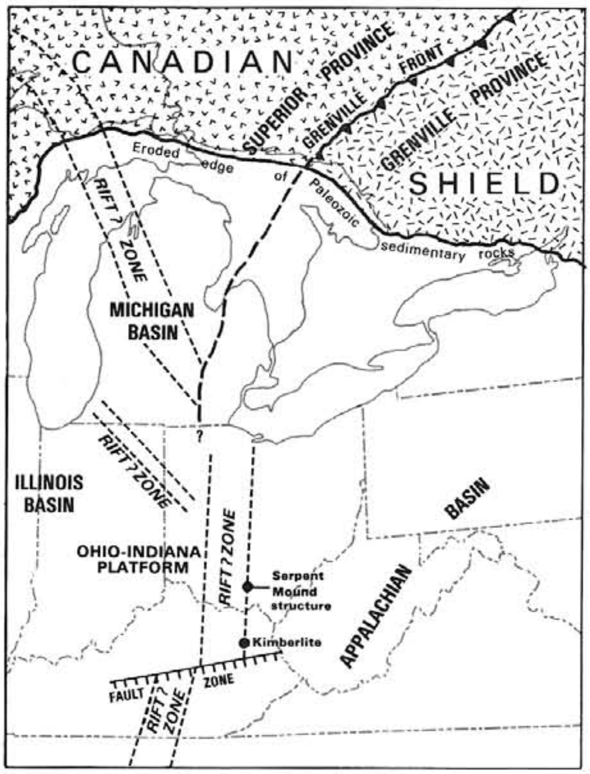
What has been ascertained from these deep wells is that the basement rocks east of west-central Ohio are principally metamorphic rocks that yield radiometric ages of between 0.8 and 1.1 billion years. In western Ohio the basement rocks are principally unmetamorphosed igneous rocks such as granite and its finer grained equivalents, rhyolite and trachyite, that yield radiometric ages of 1.2 to 1.5 billion years.

This apparent contrast in the basement rocks of Ohio has been interpreted by some geologists to be a structural feature known as the Grenville Front, named for exposures in Canada where metamorphic rocks of the Grenville Geologic Province are in contact with older rocks of the Superior Geologic Province to the west. These Canadian Precambrian rocks are under cover of younger Paleozoic sedimentary rocks from the vicinity of northern Lake Huron southward, so that the precise southward continuation of the Grenville Front is uncertain. This contact has been placed at various locations in western Ohio and westward into Indiana, but the sparse data presently available leave this question unanswered.

The Grenville Province has been interpreted to contain rocks that were highly deformed and metamorphosed during an orogenic (mountain-building) event, possibly brought about by the collision of two continental plates about 1 billion years ago. During the long span of time, perhaps half a billion years, until the beginning of deposition of the overlying Paleozoic rocks, these mountains underwent extensive erosion. The Grenville rocks, as exposed in Canada and thought to lie beneath Ohio, represent the deeply eroded roots of this mountain range.

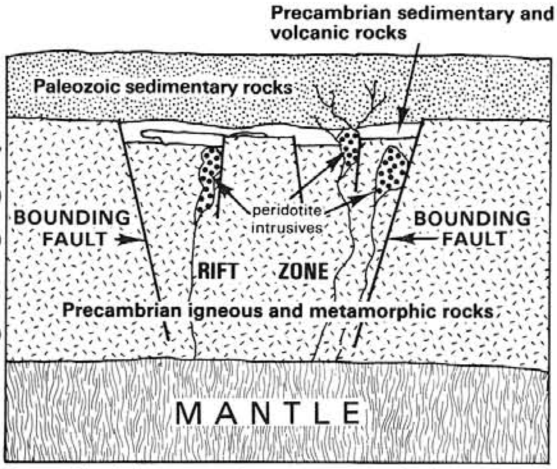
Information from deep wells also indicates that western Ohio is part of a broad, relatively shallow platform of basement rock that lies near the surface, at depths of only about 3,000 feet. Historically, this feature has been called the Cincinnati arch, but it is more precisely termed the Ohio-Indiana platform. Surrounding this platform are basins—the Appalachian basin to the east, the Michigan basin to the north, and the Eastern Interior (Illinois) basin to the west. The Ohio-Indiana platform can therefore best be viewed as a relatively stable area around which basinal areas have subsided, rather than an upwarped archlike structure.

Interestingly, the area from which the basement and overlying Paleozoic rocks dip away from the platform into the Appalachian basin coincides with some proposed extensions of the Grenville Front, with several proposed faults (including the Bowling Green fault), and with the Serpent Mound cryptoexplosion structure in Adams County. The aeromagnetic anomaly map of Ohio provides some provocative information about this zone in west-central Ohio.



Locations of basins, proposed Keweenawan fracture (rift) zones, Canadian Shield, Grenville Front, and other features.

It is immediately apparent to even the casual observer of the aeromagnetic anomaly map that west-central Ohio is marked by numerous relatively intense, circular magnetic anomalies and steep magnetic gradients along a 30-mile-wide north-south zone. This is obviously a geologically complex area



Generalized diagrammatic cross section of a fracture (rift) zone with peridotite intrusives. Such zones are linear areas of major crustal fracturing commonly marked by extensive faulting and development of a downdropped central area known as a graben. The fractures and faults may extend through the crust and provide avenues for later intrusions of mantle-derived rocks.

marked by what appear to be faults (steep gradients) and intrusions (circular anomalies) of highly magnetic rocks such as peridotites and kimberlites (see *Diamonds from Ohio, Ohio Geology,* Fall 1982).

The zone continues southward into Kentucky and Tennessee and recently has been interpreted to possibly be a fracture (rift) zone of Keweenawan age (1.1 billion years ago). This postulated late Precambrian fracture zone has apparently undergone periodic reactivation in response to recurrent crustal stresses, and the occasional earthquakes (such as the July 27, 1980, northern Kentucky earthquake) that occur in this area suggest that movement is still occurring along these ancient Precambrian zones of weakness. This north-south zone appears to be offset in central Kentucky by an east-west fault zone that is somewhat younger. An alternative interpretation to the rift hypothesis is that this zone represents the Grenville Front.

The intense circular magnetic anomalies probably represent intrusions of highly magnetic igneous rocks, but their ages are uncertain. At least one intrusion, the Elliot County, Kentucky, kimberlite, reached the surface; it has been dated radiometrically as Early Permian (about 270 million years ago) to possibly Early Triassic (230 million years ago). The Serpent Mound cryptoexplosion structure in Adams County, Ohio, originated sometime after the Early Mississippian (340 million years ago) and is thought to be related to a kimberlite intrusion that did not reach the surface except in the form of explosive gases, which deformed the rocks now exposed at the surface. At the present state of knowledge, these intrusions possibly may represent more than a single episode and range in age from late Precambrian to Mesozoic.

Speculations such as those outlined above indicate that a great deal is not known about the complex geologic history of the basement rocks of Ohio; however, the availability of the aeromagnetic anomaly map of Ohio, along with other geophysical maps soon to be published by the U.S. Geological Survey, provides the first widely available, detailed, comprehensive overview of these complex rocks in the state.

ECONOMIC GEOLOGY AND OTHER PRACTICAL CONSIDERATIONS

Perhaps one of the most intriguing aspects of the aero-

Approximate locations of Precambrian mineral deposits in the Canadian Shield and "Mississippi Valley-type" mineral districts in Paleozoic rocks in Kentucky and Tennessee.

magnetic map of Ohio is the insight it provides into the potential for economic occurrences of oil and gas and various minerals and for a better understanding of the earthquakes that periodically strike various portions of the state. The aeromagnetic map does not identify specifically any economic resources or earthquake-generating structures, but it does provide a framework for further analysis.

It has long been known that the surface of the Precambrian rocks in Ohio is not a smooth, level one—these rocks underwent considerable erosion before they were buried by Paleozoic sediments beginning in the Cambrian Period. At present, we know very little about the configuration of this surface, except in a very general way, but relief has been estimated to be as great as 500 feet in some areas; relief of 328 feet has been demonstrated in Pickaway County on the basis of a few comparatively closely spaced wells. Preparation of a contour map of the basement surface, by use of magnetic data in conjunction with deep-well data, will give us some idea of the basement-surface configuration. The delineation of ridges and valleys on the basement surface will provide potential targets for oil and gas drilling because the draping of overlying Paleozoic sediments across these basement features may have created traps for hydrocarbons.

Basement faults may extend into overlying Paleozoic rocks and provide additional hydrocarbon traps. The presumed fracture zone in west-central Ohio is particularly intriguing in this regard. In addition, basement faults and other structures, because of periodic reactivation, may have exerted control on the pattern of deposition of Paleozoic sediments, thereby creating another type of hydrocarbon trap known as a stratigraphic trap. There has been recent oil and gas exploration associated with geologically similar appearing areas, which have been interpreted as Keweenawan fracture zones, in Wisconsin, Minnesota, Iowa, Nebraska, and Kansas. One well along this zone, in northeastern Kansas, has yielded a continuous flow of free hydrogen and nitrogen gases. There are no guarantees that a big strike will occur in Ohio, but the aeromagnetic map provides insight on geologic structures and geologic history that may help to pinpoint potential target areas.

The potential for the occurrence of mineral deposits, particularly metallic minerals, in basement rocks or in the overlying Paleozoic rocks in Ohio is another enticing aspect that previously has received little attention in the state. Sulfide minerals such as sphalerite (zinc) and galena (lead) have long been known from surface exposures in west-central Ohio, but none have been found, as yet, in economic concentrations. However, the geology in this part of Ohio is very similar in many respects to that of portions of Tennessee, Kentucky, Illinois, and Missouri where sulfide minerals have been mined from "Mississippi Valley-type" deposits. Indeed, the Central Kentucky Mineral District is located on the same presumed fracture system that appears to continue northward into Ohio. Such mineralization, which resulted from hot, mineral-bearing waters ascending from the basement along fractures or faults, is much more difficult to recognize at the surface in Ohio because most of the western portion of the state is covered with a veneer of glacial sediments.

The basement rocks also have the potential for deposits of economically valuable minerals, although such deposits have not yet been identified in Ohio. Outcropping Precambrian rocks in Canada in the vicinity of the Grenville Front contain rich deposits of metallic minerals, including copper, gold, lead, nickel, silver, uranium, and zinc. Potentially, such mineralization could extend into Ohio.

Finally, the aeromagnetic map of Ohio provides important insight into the origin of the small- to moderate-sized earthquakes that are periodically felt in various portions of the state. These shocks originate in basement rocks at depths of 5 to 10 kilometers; however, almost none of the 116 earthquakes documented in Ohio since 1776 can be related to geologic structures visible at the surface. Consequently, most of these earthquakes have been in "the middle of nowhere," geologically speaking. Plotting of earthquake epicenters on the magnetic anomaly map indicates a correspondence between many earthquakes and magnetic anomalies or steep magnetic gradients in the basement. Considerable work will have to be done in order to establish precise correlations between earthquakes and specific basement structures, but the aeromagnetic map of Ohio provides an important starting point.

The aeromagnetic map of Ohio does not provide all the answers to the complex geology of the basement rocks of the state, but it does enable us to begin asking the proper questions. As additional information emerges from localized studies, we will gain an enhanced perspective on the geologic history of Ohio and a better understanding of the economic potential of the rocks that lie deep beneath the state. This last Ohio frontier is an exciting one and holds considerable promise for ample rewards to those who explore it.

FURTHER READING

Keller, G. R., Bland, A. E., and Greenberg, J. K., 1982, Evidence for a major Late Precambrian tectonic event (rifting?) in the eastern midcontinent region, United States: Tectonics, v. 1, p. 213-223.

Keller, G. R., Lidiak, E. G., Hinze, W. J., and Braile, L. W., 1983, The role of rifting in the tectonic development of the midcontinent, U.S.A.: Tectonophysics: v. 94, p. 391-412.

Nettleton, L. L., 1971, Elementary gravity and magnetics for geologists and seismologists: Society of Exploration Geophysicists Monograph 1, 121 p.

—Michael C. Hansen

The aeromagnetic map of Ohio, Residual total intensity magnetic map of Ohio, *by T. G. Hildenbrand and R. P. Kucks (1984), is a cooperative project of the Ohio Geological Survey and the U.S. Geological Survey. This is a wall-sized map at a scale of 1:500,000 with a contour interval of 50 gammas. Copies of the map, U.S. Geological Survey Map GP-961, are available from the Ohio Geological Survey for $2.33 at the Survey offices. Mail orders are $3.08 to Ohio addresses and $2.95 to out-of-state addresses. (Prices include tax, where applicable, and mailing.)*

Also available are more detailed maps of certain portions of the state. These maps are at scales of 1:250,000 or 1:62,500; contour intervals range from 20 to 50 gammas. Diazo copies of these maps are $3.50 each (either scale). Contact the Subsurface Geology Section of the Survey (telephone: 614-265-6584) for an index map or further information.

SHORE EROSION IN ASHTABULA COUNTY

Erosion along the southern shore of Lake Erie is of considerable concern to a large number of individuals who live or own property in that part of the state. County planners, engineers, landowners, realtors, and attorneys all have need for authoritative documentation on the causes of shore erosion, the rate of recession of the shoreline, projections of the expected future position of the shoreline, and abatement methods.

A study recently released by the Survey, Report of Investigations 122, *Lake Erie shore erosion, Ashtabula County, Ohio: setting, processes, and recession rates from 1876 to 1973,* is the fourth in a series of seven reports on recession rates in the counties along the Ohio shore of Lake Erie. Previous reports in this series dealt with Lake County (RI 99), Lucas County (RI 107), and Erie and Sandusky Counties (RI 115).

The Ashtabula County shore-erosion report, authored by Charles H. Carter (former Head of the Lake Erie Section) and Donald E. Guy, Jr. (geologist with the Lake Erie Section), discusses the effectiveness of various types of abatement techniques and provides data on which methods shoreline property owners might use to reduce erosion rates. The report evaluates the texture of beach and nearshore sediments, distribution of nearshore sediments, nearshore bathymetry, shore stratigraphy, and shore structures in relationship to historical recession rates of the shoreline. Changes in beaches, land use, shore-protection structures, and bluff-line positions were determined from charts prepared in 1876 and aerial photographs taken in 1938 and 1973. Recession rates were then measured for the periods 1876-1938 and 1938-1973.

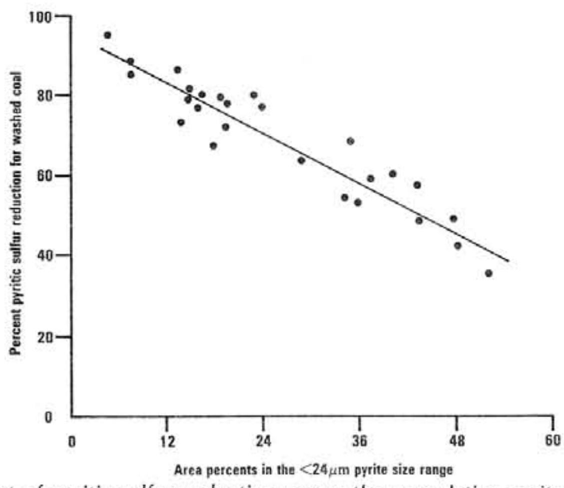
An attractive feature of this report is reproductions of the black-and-white aerial photographs (at a scale of 1:4,800) taken in 1973 that have past and projected (to the year 2010) recession lines superimposed. Report of Investigations 122 is available from the Survey for $14.91 (including tax and mailing).

PREDICTION OF PYRITIC SULFUR REDUCTION POTENTIAL OF WASHED COALS BY IMAGE ANALYSIS

The future good health of Ohio's coal industry will depend upon the ability of the industry to remove sulfur from Ohio's high-sulfur coals. At present, the most practical method of removing at least some of the sulfur is by eliminating as much pyrite (FeS_2) as possible prior to combustion. Pyrite removal can be accomplished with varying degrees of success by washing or cleaning the coal. Washing refers to the physical removal of noncoal constituents, particularly ash-forming minerals and pyritic sulfur, from the coal. In Ohio, heavy-media separation is popular for washing coal coarser than 28 mesh (595μm), whereas coal finer than 28 mesh is separated from pyrite using froth-flotation techniques.

Two important and interrelated factors which have been shown to affect the degree of pyritic sulfur reduction on washed coals are the grain-size distribution of the pyrite and the size to which the coal has been ground. Studies have shown that coals containing an abundance of coarse pyrite grains will generally have greater pyritic sulfur reductions than coals containing mostly very fine pyrite. In addition, finer grinding of a coal, to a point, will liberate more pyrite when the coal is washed. Beyond this point, which differs from one coal to the next, finer grinding will not yield substantially greater amounts of pyrite. Because of these two factors, pyrite size and coal size, it seems very likely that in the future Ohio's high-sulfur coals will have to be ground finer than is now practiced and be selected for mining based on their relative ability to release pyrite when washed.

At present, the potential sulfur reduction of very finely ground coal is difficult to determine in the laboratory because of the slow settling velocities of the grains. Generally, a centrifuge must be used to accelerate the separation of the pyrite from the coal. In addition, chemical analyses for pyritic sulfur must be performed on splits of the original samples and cleaned samples (float) in order to determine the potential pyritic sulfur reduction.



Plot of pyritic sulfur reduction versus the cumulative pyrite area percentages in the $<24\mu$m size range of unwashed coal. Pyrite size distributions determined by automated image analysis. Number of samples = 26.

A recent Survey study has shown that pyrite size distributions determined by automated image analysis can be used to predict the potential pyritic sulfur reduction of coal finer than 14 mesh (1,410μm) when washed in a 1.60 specific gravity liquid. Even though coal crushed to minus-14-mesh grain size is about the maximum size suitable for the Survey's image analyzer, there is a very good relationship between the pyrite size distribution and potential sulfur reductions for the 26 samples tested.

At finer coal grain sizes—minus 28 mesh to 200 mesh (74μm)—it is believed that the image analyzer will be able to predict the potential sulfur reduction more precisely and more rapidly simply because smaller and fewer scan areas are needed at the smaller coal grain sizes. Work in progress at the Survey is attempting to confirm this hypothesis.

—Richard W. Carlton
Regional Geology Section

WINNERS OF THE 1984 OHIO GEOLOGY SLIDE CONTEST

Ohio Geology Slide Contest winners at awards ceremony at the Ohio State Fair. L. to r.: Mike Hansen, contest coordinator; Dean Shipley (Honorable Mention); Jeffrey Story (2nd); Ann Story (4th); Trudy Beal (3rd); Gregory Mason (5th); Horton Hobbs (1st and Honorable Mention); George Houk (Honorable Mention); Eric Lanier (Honorable Mention); Horace Collins, Division Chief and State Geologist.

1st PLACE —Horton Hobbs III, Springfield: Ash Cave, Hocking County
2nd PLACE—Jeffrey J. Story, North Canton: Nelson-Kennedy Ledges, Portage County
3rd PLACE —Trudy L. Beal, Stow: Sharon Sandstone, Gorge Metro Park
4th PLACE —Ann Story, North Canton: Nelson-Kennedy Ledges, Portage County
5th PLACE —Gregory Mason, Dover: glacial outwash, Mohican River
HONORABLE MENTION—Cheryl Blevins, Glouster; Dwight Euverard, Ashtabula; Horton Hobbs III, Springfield; George Houk, Poland; Eric Lanier, Kent; Dean Shipley, Huber Heights.

The 1984 Ohio Geology Slide Contest received a record number of entries this year and once again the judges had a difficult time making final selections. Award plaques and certificates were presented to the winners in ceremonies held Saturday, August 11, at the Ohio State Fair. Prints of the winning slides were displayed in the Natural Resources Area during the fair and will be on display in the Survey lobby for the remainder of the year. The awards for the 1984 competition were sponsored by the Ohio Oil and Gas Association.

Judges for this year's competition were: David B. Buchanan, geologist, ODNR, Division of Reclamation; Charles R. Grapes, geologist, Mitchell Energy Corporation; and Alvin E. Staffan, nature photographer, ODNR, Office of Public Information and Education.

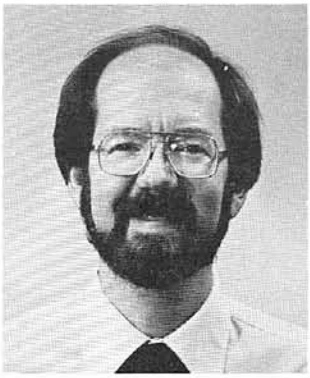
QUARTERLY MINERAL SALES, JANUARY-FEBRUARY-MARCH 1984

Compiled by Margaret R. Sneeringer

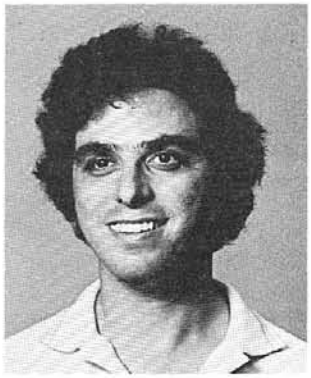
Commodity	Tonnage sold this quarter[1] (tons)	Number of mines reporting sales[1]	Value of tonnage sold[1] (dollars)
Coal	9,988,433	235	327,982,806
Limestone/dolomite[2]	4,198,785	82[3]	17,678,720
Sand and gravel[2]	2,114,136	167	5,968,271
Salt[2]	1,052,225	4[4]	11,867,810
Sandstone/conglomerate[2]	426,577	16	5,848,557
Clay[2]	190,428	16[3]	765,671
Shale[2]	141,560	10[3]	270,336
Gypsum[2]	50,589	1	480,596
Peat	132	1	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.

SURVEY STAFF NOTES



Clark Scheerens



Lenny Guckenheimer

Clark Scheerens is a geologist in the Regional Geology Section and has responsibilities for coal investigations. Clark has worked on projects on Lower Pennsylvanian coals in southern Ohio and has been active in evaluating coal data obtained by the Survey's core-drilling rig. He particularly enjoys providing coal information to industry and the general public.

Clark is a native of Rochester, New York, and has a B.S. degree in geology from SUNY-Brockport and an M.S. degree in geology from the University of Toledo. He is married and enjoys photography and participating in sports such as softball and volleyball.

Leonard Guckenheimer has been a cartographer in the Technical Publications Section since 1979. Lenny had previously been a cartographer with the Jacksonville, Florida, planning commission after receiving a B.A. degree in geography from the Ohio State University. The variety of cartographic activities at the Survey have been of particular interest to him. Lenny has worked on numerous maps and other projects, including the Eastern Gas Shales Project.

Lenny is a native of Columbus, is married, and has one child. He enjoys outdoor activities such as bicycling, hiking, canoeing, and playing on the Survey's softball team.

HANDLING CHARGE INCREASE

The following schedule for handling charges for all Survey publications is now in effect. Please add the handling charge, plus 5½ percent sales tax for orders to be delivered in Ohio, to the cost of publication(s) ordered.

Cost of publications	*Handling charge*
\$0.10-\$3.00	\$0.75
\$3.01-\$5.00	\$1.25
\$5.01-\$10.00	\$1.75
\$10.01-\$20.00	\$2.25
\$20.01-\$30.00	\$3.00
\$30.01-\$50.00	\$5.00
\$50.01-\$100.00	\$5.00
over \$100.00	\$7.50

FREE ITEMS: The first five free items ordered will be mailed at no charge. For each additional five free items (or fraction thereof) please include 25¢ for postage and handling.

SURVEY STAFF CHANGES

COMINGS

Roy T. Dawson, Assistant Driller, Regional Geology Section.

Jack A. Leow, Geologist, Regional Geology Section.

Gregory A. Schumacher, Geologist, Regional Geology Section.

Sherry L. Weisgarber, Geologist, Regional Geology Section.

Cynthia L. Westbrook, Cartographer, Technical Publications Section.

AND GOINGS

Douglas C. Coll, Assistant Driller, Regional Geology Section.

Katherine L. Jennings, Cartographer, Technical Publications Section, to U.S. Geological Survey, Denver, Colorado.

Renia Peterson, Public Inquiries Assistant, Public Service Section, to San Diego, California.

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