Ohio Geology

Ohio Department of Natural Resources, Division of Geological Survey • 2007, No. 1

The new *Bedrock Geologic Map of Ohio*

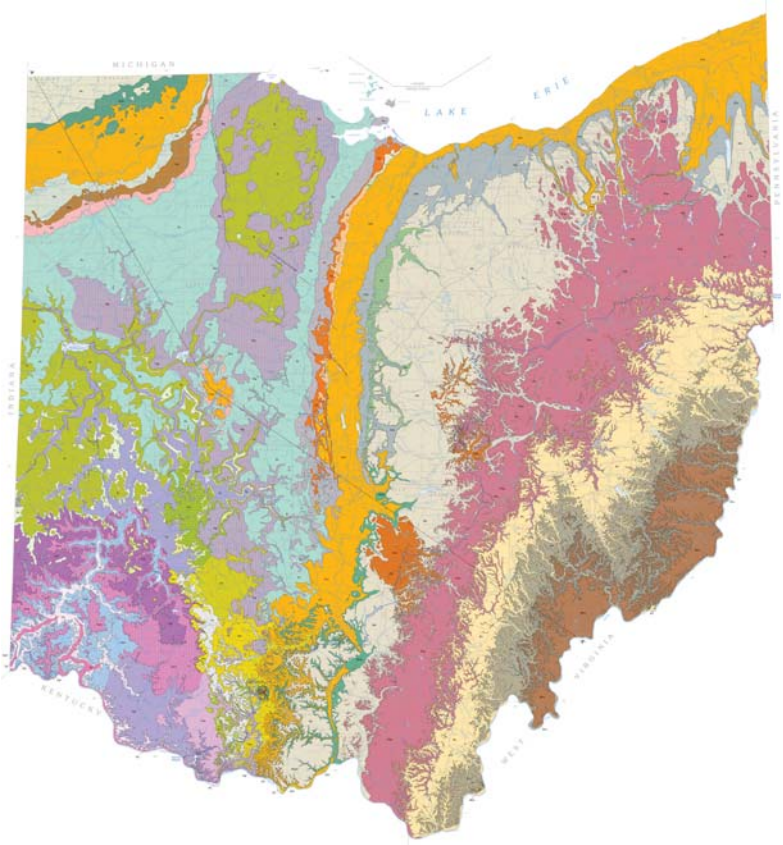
By Mac Swinford,
With portions from previously published issues of *Ohio Geology*

The Ohio Division of Geological Survey achieved a milestone in September 2006, when 5,000 copies of the new *Bedrock Geologic Map of Ohio* were printed. The publication of this map marks the culmination of a 25-year effort by Survey staff to remap the bedrock geology of Ohio.

The 2006 *Bedrock Geologic Map of Ohio* is a work of artistry and science. It contains an intricate mosaic of colors and patterns that depict the distribution of near-surface bedrock geology across the state. Essentially, the map displays the bedrock units at ground surface, or the first bedrock unit encountered beneath surficial deposits that cover the bedrock. The map shows the distribution of 45 bedrock units across the state on a modern base map.

Sections of the new bedrock map, such as portions of southeastern Ohio, strongly resemble the 1920 map and testify to the excellent geologic mapping conducted between 1890 and 1920. Of course, economically important Pennsylvanian-age coal-bearing rocks dominate southeast Ohio, a fact that focused the Survey's work through the early and mid twentieth century. The detailed mapping of those rocks is reflected on the 1920 state geologic map, and in many respects is carried over to the 2006 version. However, the new map's depiction of western Ohio contains an immense amount of added detail in stark contrast to the 1920 map. This is largely because buried-valley systems were only roughly understood prior to 1920. The best example of such a major update is the 450 feet-deep, ancestral Teays Valley and its tributaries that deeply slice through several Silurian-age bedrock formations from London, Ohio to Grand Lake St. Mary's and beyond to reveal older Ordovician bedrock beneath.

Also included with the map is a cross section. The section traces along a line from the Ohio River in Washington County, to Bellefontaine in Logan County, and then to Williams County in the northwest corner of the state. The cross section at the base of the map is a vertical slice through many of the state's bedrock formations from ground surface to deep beneath Ohio (over 5,000 feet). The cross section shows the dip or tilt of layers, which resulted from the formation of regional structural features such as the Appalachian Basin, the Cincinnati Arch, and the southwest corner of the Michigan Basin. There are also three inset maps: the generalized, statewide, drift-thickness map of surficial deposits; the statewide major structural features map; and a detailed geologic map of the Serpent Mound Impact Structure.



The 2006 Bedrock Geologic Map of Ohio is the first major update of the bedrock map of the state since 1920. This map is the result of over 20 years of intensive data gathering, map drawing, and digital compilation by Division staff. The map is at a scale of 1:500,000 (one inch equals 8 miles) and the map dimensions are 42 inches in height by 50 inches in width.

continued on page 3

OHIO ROCKS!

Larry Wickstrom,
Division Chief and State Geologist

On February 12, 2007, ODNR Director, Sean Logan, appointed Larry Wickstrom as Chief of the Division of Geological Survey and Ohio's 12th State Geologist. Larry has been a Division employee for 24 years as a geologist and manager.

We can safely say that a lot of change is taking place in Ohio and at the Division of Geological Survey. At the state level, of course, we have our new governor, the Honorable Ted Strickland. This yields a new administrative team at ODNR, our new Director, Sean Logan, plus his new administrative team, and new Division chiefs.

Here at the Division of Geological Survey we have been going through numerous personnel changes. When you read this issue's *Comings and Goings*, observe that the Division of Geological Survey had five full-time staff retire between August 1 and October 31, 2006. Three of the five were administrative—Tom Berg, Division Chief; Dennis Hull, Assistant Division Chief; and Garry Yates, Supervisor of the Geologic Records Center (GRC). The remaining retirees also held key positions: Don Guy, Senior Geologist in the Lake Erie Geology Group; and Sharon Stone, Administrative Assistant (her many duties included performing the role of the Division's Human Resources Officer). Sharon Lundy, a part-time GRC Customer-Inquiries Assistant, also retired at the end of September 2006. The years of experience and leadership of the recent retirees will be missed by the agency and the citizens of Ohio.

Added to other recent retirements that were not replaced, our Division's staff level fell to 20 full-time employees: This is a level of staffing completely inadequate to run a modern state geological survey. Therefore, beginning in July, a Staff Realignment and Hiring Plan was prepared and subsequently approved by the ODNR administration, with one minor caveat—the Division of Geological Survey was required to complete all hiring prior to December 8, 2006, because of a new centralized personnel and accounting system that the state began implementing on that date.

Thus, it was a grueling race to maintain scientific projects and administrative duties as we developed all necessary documents, advertised and posted position vacancies, pre-screened applicants, interviewed candidates, and filed all paperwork on time. We were able to accomplish hiring seven new highly qualified staff to the Survey! This is the most hiring done at the Division since the mid-1980s. We look forward to new ideas and invigoration from all of our new staff. I thank all the staff for their diligence and patience through this process, and I especially thank all the supervisors who assisted in the hiring/interview process.

It is particularly important that the Division of Geological Survey staff be rejuvenated right now, for there are so many changes taking place in our society that need the expertise that only a state geological survey provides. Two areas that require attention in the near term are energy and geohazards. The production of energy in the United States is set to change dramatically from that of the past 50 years or so. Factors that produce the pressure to change come from different quarters: our response to global climate change and to natural disasters such as hurricane Katrina; our heightened awareness of energy insecurity, sharpened by the attacks of September 11, 2001, and subsequent events; and our response to worldwide increased energy prices. All of these factors have led to our nation's reexamination of the U.S. energy situation, and the realization of the need to set a new and better course. The U.S. possesses the resources and technology to produce more domestic energy, yet this will require major change within our energy infrastructure. New energy resource mapping and analyses by the state geological surveys will be needed now more than ever.

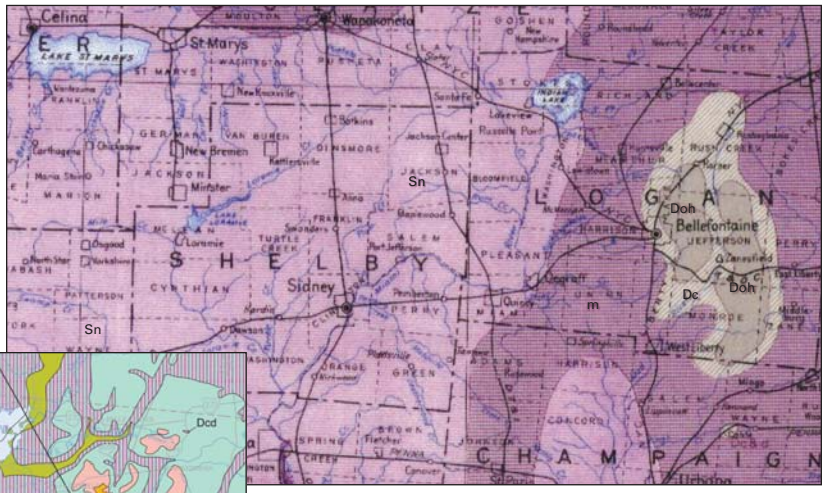
Damage from geohazards is escalating within Ohio. Ohio citizens need proper mapping and analyses of geologic hazards such as karst (sinkholes), landslide and rockfall potential, earthquake damage potential, underground-mine subsidence risk, and shore erosion potential. Our research also helps guide remediation efforts, assists in proper siting of new roads, sewer tunnels and other infrastructure, and can be used in regional planning efforts to avoid future costly mistakes.

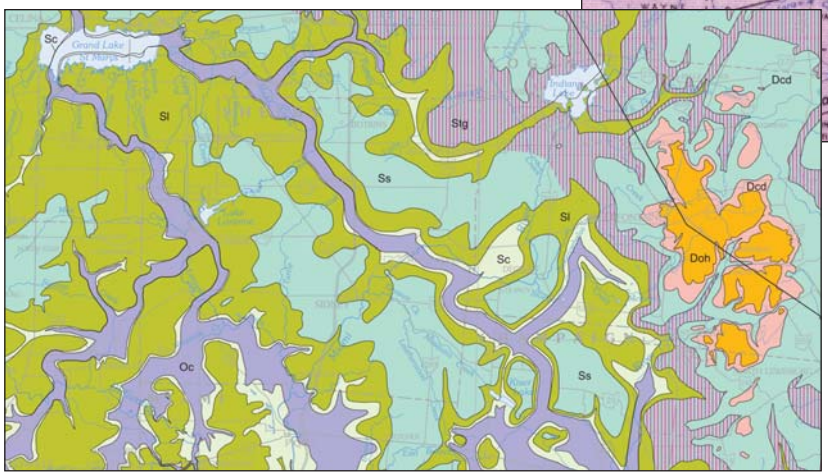
Future *Ohio Geology* articles will expound on the energy and geohazards research needs of the state and keep our readership appraised of our efforts to address those needs. Change can be good, but you have to be prepared for it.

continued from page 1

1920 Bedrock Geologic Map Legend

Doh Devonian Ohio Shale
Dc Devonian Columbus
m Devonian-Silurian Monroe
Sn Silurian Niagara





2006 Bedrock Geologic Map Legend

Doh Devonian Ohio Shale
Dcd Devonian Columbus and Delaware Formations
Ss Silurian Salina Group
Stg Silurian Tymochtee and Greenfield Dolomite
Sl Silurian Lockport Dolomite
Sc Silurian Cataract Group
Oc Ordovician Cincinnati Group

Comparison between the 1920 and 2006 geologic maps for a portion of western Ohio. This illustrates the vast increase in detail provided by the new version. The remapping of the bedrock topography (upper surface of the bedrock beneath glacial drift) was performed in concert with the bedrock geology, a process that revealed the intricate system of valleys that cross western Ohio but are partially or completely buried by glacial deposits. The presence of these buried valleys was just being recognized when the 1920 map was released.

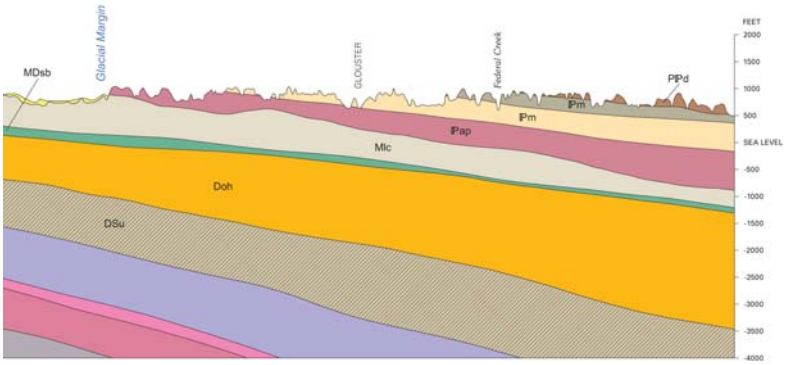
The *Bedrock Geologic Map of Ohio* was generated from a compilation of 788 7.5-minute bedrock geologic quadrangles, mapped between 1985 and 1997. The mapping of all 788 quadrangles distinguishes Ohio as one of a few select states in the nation to have complete bedrock map coverage at the 7.5-minute scale. A detailed discussion of the history, and the methods used to complete the map, are covered in the spring 1997 issue of *Ohio Geology*.

The accompanying text to the map presents a brief overview of the methodology used to compile the map and discusses the general geology, economic geology, and geologic hazards associated with Ohio's surface bedrock. The rock types and their distinguishing characteristics are summarized by geologic system along with a discussion of whether the Dunkard rocks are Pennsylvanian or Permian in age. The text describes the major elements that control the distribution of the bedrock contacts, which include erosion, structure, and original depositional patterns. The text describes the profound influence that glaciation and pre- and post-glacial drainage systems had on the configuration of the bedrock surface. Many of the valleys were smoothed by glaciation and completely or partially buried by glacial drift.

The four major structural elements that control the distribution of Ohio's bedrock are the Appalachian and Michigan Basins, and the Cincinnati and the Findlay Arches. These are discussed along with regional features such as the Cambridge Arch, the Parkersburg-Lorain Syncline, the Ashley Anticline, and the Serpent Mound Impact Structure. Also, the Bowling Green, Outlet, and Middleburg faults are discussed along with smaller faults.

The economic geology section describes extraction, distribution, and uses of oil, gas, coal, limestone, dolomite, and shale. Clay, sandstone, conglomerate, silica sand, rock salt, and gypsum deposits are also discussed, as are historically important deposits such as ironstone and flint. A short summary is given regarding the presence of diamonds and gold in Ohio, plus the influence of bedrock type (sandstone and limestone versus shale and clay) on groundwater supply from bedrock.

Lastly, geologic hazards are addressed. Across the state, formations that are both shale-



A small portion of the cross section from the 2006 map. The section trace crosses Ohio from West Virginia to Michigan and shows the vertical sequence of formations.

dominant and are exposed in areas of high relief often are unstable, resulting in significant damage to structures and property because of landslides. Examples include the Kope Formation of southwestern Ohio, the Bedford Shale of south central Ohio, or the Conemaugh, Monongahela, and Dunkard Groups of eastern Ohio. Oversteepened hillslopes, or the removal of slope toes by construction or mining, commonly cause colluvium (weathered bedrock and soil) on these hillsides to fail and form landslides. Geologic hazards are summarized and are described in association with 1) underground mining primarily in coal fields of the state; 2) karst (sinkholes, caves and caverns) in limestone and dolomite bedrock in south central to north central portions of the state; 3) earthquake hazards; and 4) the naturally occurring radioactive gas, radon. References for further reading on these subjects are provided on the map.

A short history of previous official bedrock maps of Ohio—a summary from *Ohio Geology*, Spring 1990

The new bedrock map of the state is a continuation of a long line of bedrock maps produced by the Ohio Geological Survey, each created to reflect new information about the state's bedrock geology for use by private citizens, industry, and government officials. The first official map was published in 1870 in the *Report of Progress in 1869,* when the reactivated geological survey was under the direction of John Strong Newberry, the second State Geologist. This reconnaissance-scale map (1 inch equals 18 miles) depicted 13 geologic units on a detailed base map for that time period. The Newberry Survey continued to collect detailed geologic data through 1874, which led to a major update of the map and the publication of the 1879 state geologic map in the *Geologic Atlas of Ohio*. The map, printed on six separate sheets at a scale of 1 inch equals 4 miles, shows, in remarkable detail, the distribution of 13 stratigraphic units with a cross section.

Edward Orton, third State Geologist of Ohio, focused on economic geology, which led to publication of the 1888 geologic map of Ohio. This map was at a scale of 1 inch equals 8 miles (the same scale used on all subsequent state bedrock maps) and depicted seven geologic units.

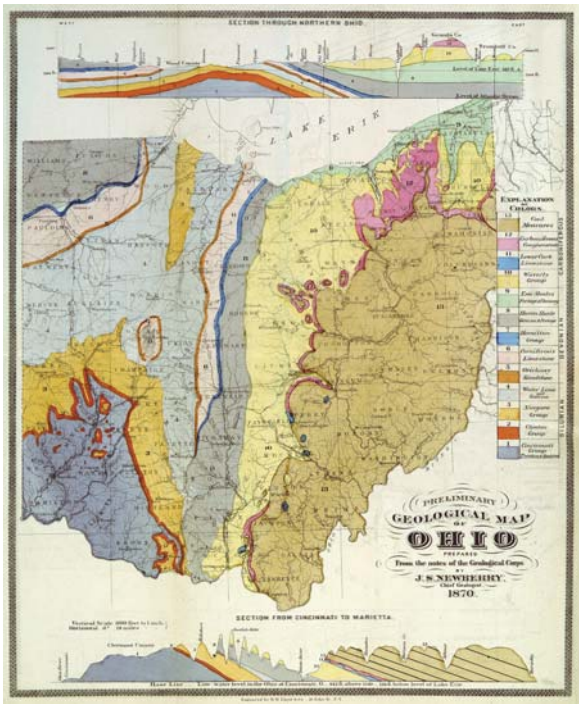
Partial availability of U.S. Geological Survey 15-minute series topographic maps afforded the fifth State Geologist, John A. Bownocker, a new and powerful tool to update the map, yet again. The 1909 Bownocker map showed the accurate portrayal of eleven geologic units in relation to topography, where topographic maps were available, and the map also displayed the locations of oil and gas fields, gypsum mines, and cement and gypsum works. Interestingly, this map was the first to show the Ordovician System and the subdivision of the Carboniferous rocks into the Mississippian and Pennsylvanian Systems, a distinction that had just been accepted for use by the U.S. Geological Survey.

By 1916, Ohio had complete coverage of 15-minute topographic maps. Bownocker issued a new bedrock map to reflect updates based on mapping aided by these new base maps. Bedrock contacts on fourteen units shown on the map are drawn to follow topographic contours, and reveal extraordinary detail. Bownocker's 1920 map, reprinted four times, was the official geologic map of Ohio for 86 years, longer than all the previous versions combined.

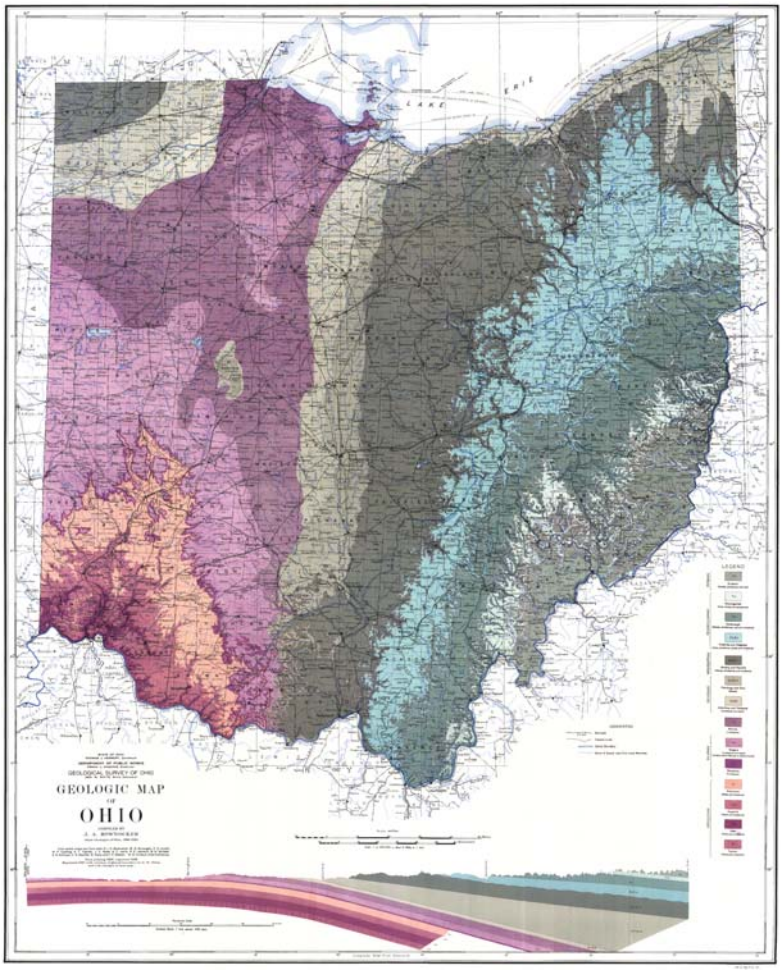
Uses for a new bedrock map

The Division of Geological Survey spends considerable effort and funds updating and improving the bedrock geologic map because it is an efficient method for conveying extraordinary amounts of geologic information about the distribution of near-surface bedrock. The science of geologic map making, in the modern sense, was developed by William Smith, an English canal surveyor, who in 1815 released the first detailed geologic map of England, entitled, *A Map of the Strata of England and Wales with Part of Scotland*. Just as William Smith documented the geology of England during his extensive travels over many years, Ohio Geological Survey geologists collected new data and also used all existing data from earlier workers.

The new *Bedrock Geologic Map of Ohio*, and the explanatory text, figures, cross section and



Newberry's preliminary geologic map of Ohio, published in 1870, was the first official geologic map of the state.



The Bownocker map. This map was published in 1920, then reprinted in 1929, 1947, 1965, and 1981, was Ohio's official bedrock geologic map for 86 years and the nations oldest official state geologic map until replaced in 2006.

the 7.5-minute bedrock-geology maps from which the 1:500,000-scale map was compiled are useful to geologists. These maps also are important to the mineral industries exploring for new deposits, to planning and engineering agencies concerned with the geohazard potential of local geologic features, and to citizens and hobbyists seeking information on interesting rock formations and potential mineral deposits. Of course, the scale of the state map limits its usefulness for detailed analysis, since 1 inch on the map equals 8 miles on the ground. Additionally, the map was compiled from more detailed 1:24,000-scale maps (1 inch equal 2,000 feet), which were, in some cases, generalized for the published 1:500,000-scale map. Still, oil and gas explorationists will review the pattern of outcrop lines on the map, looking for linear features that are perhaps controlled by deep geologic structures, and that could also trap petroleum deep below ground surface. Hobbyists will scour the map, looking for the distribution of the Ordovician-age Waynesville Formation within which the prized fossil trilobite-rich beds reside or the outcrop pattern of the Devonian-age Silica Formation in northwestern Ohio, a world famous, fossil-rich formation.

The new bedrock map is for all Ohioans to use and enjoy. The map compiler, Senior Geologist Ernie Slucher, invested thousands of hours to make sure the map, text, and figures were as correct as possible and remained truthful to the 788 quadrangle maps from which the publication is based. Ernie and the staff of the Technology Transfer Group are to be commended for creating a product that makes the map, text, and figures both informative and pleasing to the eye.

Behind every line, color, explanation, and chart is an immense catalog of geologic science and research gathered and faithfully documented by geologists of the past and present and brought forth into a unified map by the geologists of the Geologic Mapping and Industrial Minerals Group. These employees and former employees are proud to have their names associated with the map, and they look forward to the citizens of the state using the map and learning about the bedrock geology of Ohio.

The *Bedrock Geologic Map of Ohio, BG-1*, contains the near-surface bedrock map, 3 figures and 1 cross section to illustrate Ohio geology. Copies of the *Bedrock Geologic Map of Ohio* are available for $15 each, folded, plus shipping and handling. Unfolded (rolled) versions are available

for an additional fee of $1.50. Orders are subject to Ohio state sales tax and applicable county taxes (Ohio addresses only). The bedrock map may be ordered from the Geologic Records Center by calling 614-265-6576, by fax (614-447-1918), email (geo.survey@dnr.state.oh.us), or writing ODNR Division of Geological Survey, 2045 Morse Road, Bldg. C-1, Columbus, Ohio 43229-6693. Visa and MasterCard are accepted.

Further reading

Swinford, E.M., 1997, Remapping of the bedrock geology of Ohio completed: Ohio Geology, Summer, p. 1, and 3-5.

Hansen, M.C., 1990, History of the geologic map of Ohio—Geology emerging: Ohio Geology, Spring, p. 1, and 3-5.

_____1982, Geologic maps—Bedrock: Ohio Geology, Spring, p. 3-4.

LOOKING BACK

The road to the successful production of the *Bedrock Geologic Map of Ohio* began in the late 1970s as the need for an updated map became apparent to policy makers, industries, and citizens. This effort included devising a stable mechanism to fund a multi-year program, hiring geologists and support staff, and performing many years of geologic mapping to produce an accurate and modern depiction of Ohio's bedrock geology.

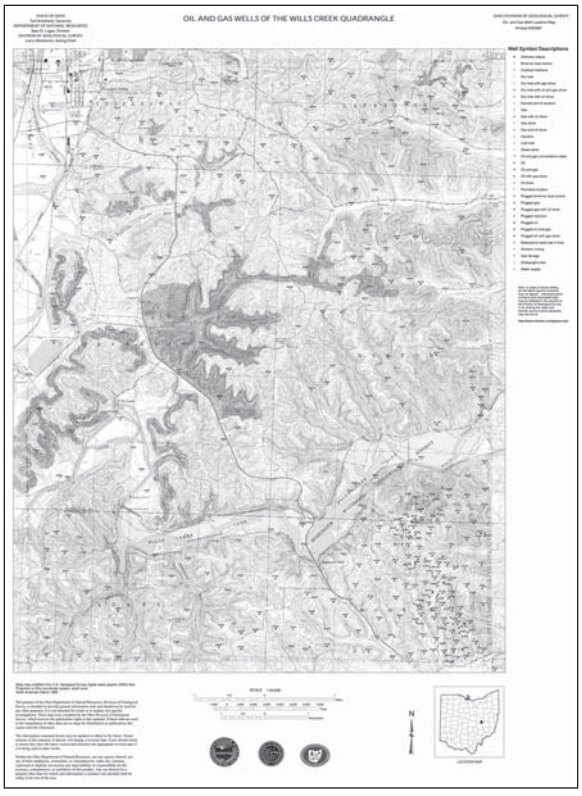
The tenth State Geologist, Horace R. Collins, saw the need for mapping, envisioned a focused mapping program, and took a series of important steps. He laid the groundwork for funding (through a severance tax on Ohio mineral and oil and gas industries) and hired mapping and support personnel to ensure the work was sustained over the long term.

The eleventh State Geologist, Thomas M. Berg, applied his personal experience managing the mapping effort for the update of Pennsylvania's geologic map to updating Ohio's geologic map. His vision was to replace the bedrock map as fast as possible through reconnaissance mapping of all 788 quadrangles, using existing data supplemented with new data from drill holes, where possible. Also, Thomas Berg promoted the use of grants and other outside funding sources to speed the process along.

Through the vision and leadership of these two State Geologists, and the hard work of dedicated staff, an exceptional map compilation of geologic science and information has been created for all Ohioans to enjoy.

New oil & gas well location maps available on paper or on the web

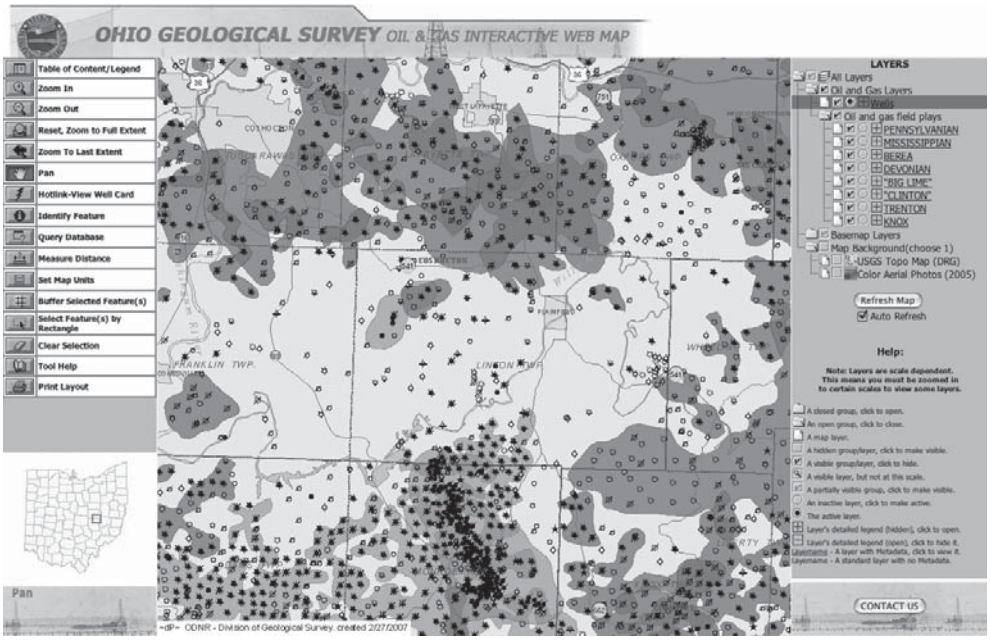
Oil and gas well location maps are now available as full-color prints on standard 7.5-minute U.S. Geological Survey topographic quadrangle maps and as an Internet-based interactive map. Previously, oil and gas well location maps were black and white planimetric (cultural information only) maps based on civil township boundaries. These new maps and web-based products can be used for oil and gas exploration and development. Geologic researchers, environmental professionals, city and regional planners, and landowners will also benefit from using these maps for information gathering.



Printed maps

The new printed map products (at right) show the location, permit numbers, producing zone, and well status, on each of Ohio's 788 quadrangles. These new maps provide up-to-date well information on a convenient base map, and contain far more information than the previous township-based maps, which ceased being updated in 2005.

Interactive maps



Available on the Division's website is an entirely new method of viewing well information and locations, **http://www.ohiodnr.com/geosurvey/**. Oil and gas well locations are viewed upon a user-selected map background, either the full-color image of a U.S. Geological Survey topographic map or a color aerial photograph. The online interactive map application (at right) allows users to view

- Each oil and gas well location,
- Data pertaining to individual or groups of wells, and
- Show-producing areas by geologic horizon.

The user selects the desired level of detail from a list of features such as county and township boundaries, original land subdivisions, cities, roads, and rivers.

An interactive map helps users to perform customized queries and prints for their individual needs. Using the built-in tools, users can create maps showing only wells producing from a certain geologic interval and include such features as

- The type of production (oil versus gas),
- Production depth, and
- Proximity to city boundaries.

The web-based map also has links to more than 177,000 scanned images of historic well-completion records on a well-by-well basis.

Printed well location maps cost $8.00 each (plus sales tax, shipping and handling). To order printed paper maps, contact the Geologic Records Center, 2045 Morse Road, Bldg. C-1, Columbus, Ohio 43229-6693; telephone: 614-265-6576; fax: 614-447-1918; email: geo.survey@dnr.state.oh.us. In-state sales tax rates are based upon the county where the map is shipped. Handling charges apply to all mailed orders (Please call for rates). Visa and MasterCard are accepted.

New Lake Erie publication

The Ohio Division of Geological Survey recently released Report of Investigations 148, *Archeological Search for shipwrecks in the vicinity of Kelleys Island, Lake Erie: A pilot study, August 2003*, by Dale L. Liebenthal, J. A. Fuller, and Constance J. Livchak. The authors were able to locate a total of seven shipwrecks using Global Positioning System technology combined with side-scan sonar, the same technology used to find the shipwrecks of the *Titanic* and the World War II German battleship *Bismarck*. The sunken remains of the *George Dunbar, Amaretta Mosher*, and *F. H. Prince* were accurately located and mapped. Four wrecks, located to the west and southwest of Kelleys Island, are likely the ships *Oak Valley, L. B. Crocker, C. H. Plummer*, and the tugboat *Relief*.

The authors also used side-scan sonar to investigate the Gull Island Shoal, known as the most treacherous reef in Lake Erie. Although wrecks are believed to be associated with this reef, no shipwrecks were positively identified nearby.

This report may be ordered from the Geologic Records Center, 2045 Morse Road, Bldg. C-1, Columbus, Ohio 43229-6693; telephone: 614-265-6576; fax: 614-447-1918; email: geo.survey@dnr.state.oh.us. Price is $10.00 plus sales tax. In-state sales tax rates are based upon the county where RI 148 is shipped. Handling charges apply to all mailed orders (Please call for rates). Visa and MasterCard are accepted.

The *George Dunbar*

Survey staff changes

Comings:

- Elizabeth M. Alguire—Executive Secretary, Administration
- Katie L. Cade—Secretary (part-time), Lake Erie Geology Group, started June 2006
- Christopher P. Gordon—Geologist 1, Energy Resources Group
- Paul M. Harbulak—Geographic Information Management Systems Specialist 2, Lake Erie Geology Group
- Sharon L. Kozak—Geologist 3, Lake Erie Geology Group
- Douglas J. Mullett—Geology Program Supervisor, Energy Resources Group
- Christiana A. Tickle—Publications Editor, Technology Transfer Group
- Erik R. Venteris—Geologist 3, Geologic Mapping and Industrial Minerals Group, started October 2005
- Kelli L. Vogt—Geographic Information Management Systems 1, Technology Transfer Group

Goings: *Visit the division website for career summaries of selected individuals listed below.*

- Thomas M. Berg—State Geologist and Chief of the Division of Geological Survey 1989-2006, retired with 17 + years of service
- Stephen J. Galbreth—Research Vessel Operator, Lake Erie Geology Group
- Don E. Guy Jr.—Geologist 4 for the Lake Erie Geology Group, retired with 34 years of service
- Dennis N. Hull—Assistant State Geologist and Assistant Chief of the Division of Geological Survey, retired with 29 + years of service
- Sharon E. Lundy—Office Assistant, Technology Transfer Group, retired with 7 years of service
- Sharon L. Stone—Administrative Assistant 3, retired with 14 years of service with the Geological Survey
- Garry E. Yates—Natural Resources Administrator, Technology Transfer Group, retired with 30 years of service

Ohio Geology—2006 newsletter clarification

Only one newsletter was published during 2006. Our regular Ohio Geology newsletter schedule was held up due to changes in personnel during 2006. The Division regrets omitting the second 2006 newsletter from our schedule.

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