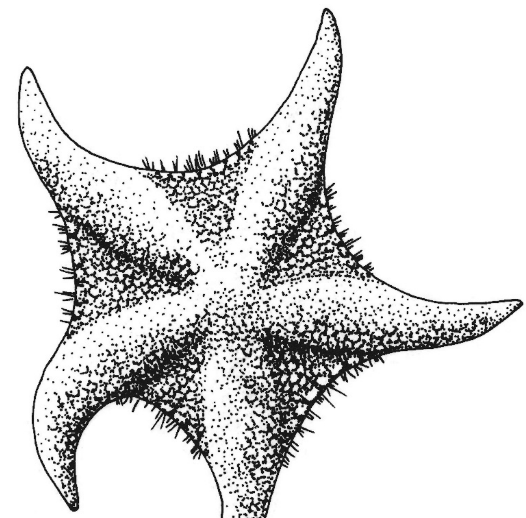
VOL. 35, NO. 3/4

# Pennsylvania GEOLOGY



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# ON THE COVER

A Devonian encrinasterid brittle star *(Encrinaster).* The encrinasterids are a group of extinct brittle stars that have characteristics showing their close affinity to sea stars. A fossil found along the shore of Lake Erie belongs to this echinoderm group (see article on page 2). Sketch by John A. Harper.

# PENNSYLVANIA GEOLOGY

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**VOL. 35, NO. 3/4** **FALL/WINTER 2005**

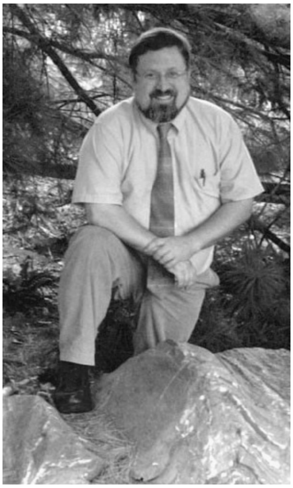
STATE GEOLOGIST'S EDITORIAL

# Change

The Bureau of Topographic and Geologic Survey hired a large number of people back in the 1970s, and as a result, today we face a demographically skewed workforce. Within the past four years, seven of our staff members have retired (see article on page 17). This provides opportunities of one kind; we have been fortunate enough to hire as replacements people who bring their own strengths. Yet it also means that we have suffered a tremendous loss of technical expertise and experience.

For example, the geologic mapping staff has gained a rich appreciation of the complexities of geology in the state, and in so doing, has gained encyclopedic knowledge of various locations. Each generation of Bureau geologists has studied various aspects of the geology of our commonwealth, and has provided new insights. But when the individuals retire, much of their knowledge goes with them.

Technological changes over time were reflected in the changing nature of the careers of all of the retirees as they acquired new technical skills upon entering the age of computers. A specific example is the career of Cheryl Cozart; she started by producing letters from dictation and ended by running a sophisticated database of oil and gas records. All seven are adaptable individuals who were dedicated to service and grew and flourished in the Bureau.



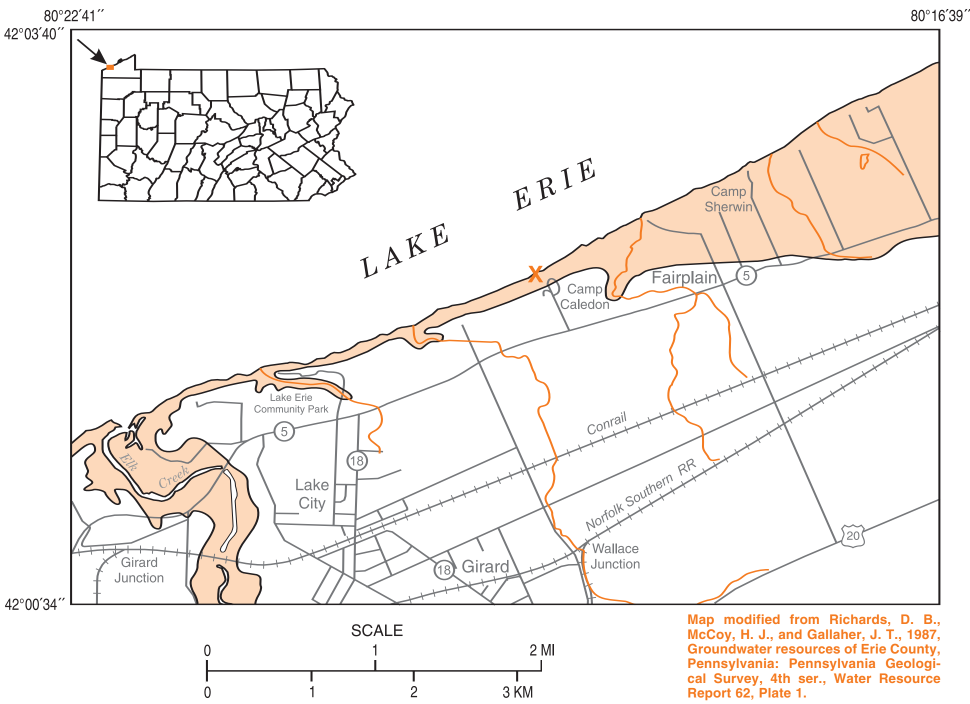
In the end, we are an organic institution, changing in the same way as the environment we study. We will face losses, as you will see in this issue. And we will have new faces, as you will see in the next.

Jay B. Parrish
State Geologist

# Reflections on a Devonian Brittle Star From the Shore of Lake Erie

by John A. Harper and Helen L. Delano
Bureau of Topographic and Geologic Survey

**ONCE UPON A TIME.** While doing fieldwork in Erie County, Pa., in the 1980s, Helen found part of a fossil starfish on the surface of a slab of calcareous shale at the foot of the Lake Erie bluff near Fairplain, Pa. (Figure 1). Knowing of John's interest in fossils, especially starfish, she gave it to him, and for a while it was in his office gathering




Map modified from Richards, D. B., McCoy, H. J., and Gallaher, J. T., 1987, Groundwater resources of Erie County, Pennsylvania: Pennsylvania Geological Survey, 4th ser., Water Resource Report 62, Plate 1.

**Figure 1. A portion of Erie County, Pa. An X marks the location where the Devonian brittle star fossil was found, possibly eroded from the outcrop of the Northeast Shale. The mapped extent of the Northeast Shale is shown in light orange; the approximate location of the figure is shown on the inset map of Pennsylvania.**

dust. But starfish fossils are relatively rare and need to be made available for study. Therefore, we have recently picked up this specimen, dusted it off, looked it over, and are now attempting to do something useful with it so that we are not just providing the world with another doorstop or paperweight.

**WE'RE NOT BLUFFING ABOUT THIS SLAB.** The Lake Erie bluff near Fairplain is 80 to 85 feet high. The lower 5 feet or so is bedrock consisting of shales and siltstones of the Upper Devonian Northeast Shale; the remainder of the bluff consists of a variety of Pleistocene glacial and glacial lake deposits. The beach at the toe of the bluff is composed largely of thin siltstone and shale slabs ranging from several inches to 3 or 4 feet in diameter that have been weathered out of the outcrop and battered by Lake Erie waves.

The fossil-bearing slab originally measured about 1 or 2 feet in diameter and 2 to 3 inches thick, but it was subsequently broken to provide portability. The resulting fragment (Figure 2A), which is highly calcareous, displays a distinct pattern of concentric fracturing and, in cross section, inclined laminations. This is a concretion, with the fossil at the center (Figure 2B) acting as a nucleus. The relative thinness and fragile nature of the slab suggest that it had not been transported far, but there is no conclusive evidence indicating that it came from the exposed bedrock in the immediate vicinity. Both the slab and the fossil have been highly weath-

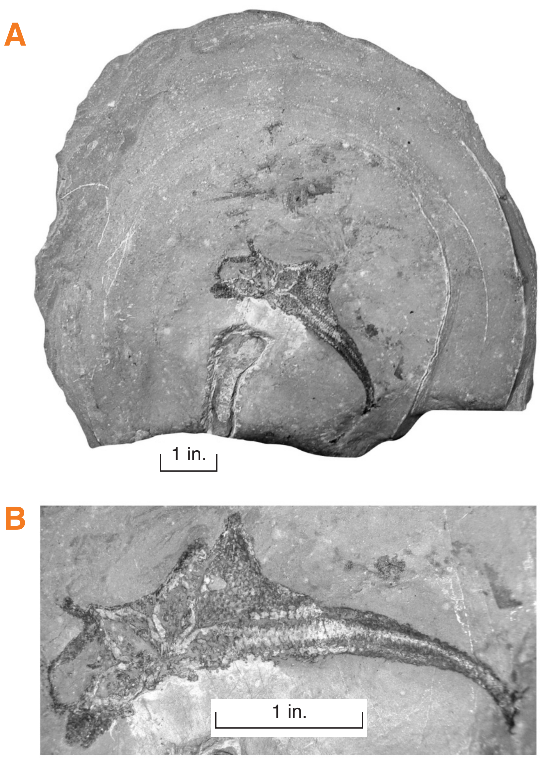



**Figure 2. Photographs of the brittle-star fossil in the calcareous shale slab. A. Full slab. The large gouge below the fossil resulted from an unsuccessful attempt to excavate what appeared to be a buried partial arm. B. Close-up of the fossil.**

ered. The fossil consists of part of the central body and one nearly complete arm (Figure 2B). An unsuccessful attempt was made to excavate what appeared to be a fragment of an arm buried in the matrix; this resulted only in a gouge carved into the slab (Figure 2A). Most of the surface details of the individual plates of the specimen have been sufficiently weathered to make complete, positive identification of the fossil impractical, if not impossible. Still, the discovery of this specimen is noteworthy because fossil starfish are so rarely preserved.

**THE SPARSE WORLD OF FOSSIL STARFISH.** Asterozoans, those echinoderms we call starfish, include the extinct somasteroids, the sea stars (what we normally think of as starfish), and brittle stars. The latter two groups are among the more common invertebrate animals in the world's oceans—about 3,800 species have been described (Hendler and others, 1995). They are, however, among the rarest of fossils, particularly as complete or nearly complete specimens. Starfish have skeletons made up of numerous calcareous plates, called *ossicles,* which are bound together by strong muscles and fleshy skin. When the animal dies, the tissue decays, and the skeleton, having nothing to hold it together, falls apart and is scattered by currents and burrowing organisms. Sea-star fossils, superficially more common than brittle-star fossils because their ossicles are larger and more readily preserved, generally are easier to find and recognize. It is not an uncommon event to find scattered sea-star ossicles at a site rich in other echinoderm fossils, such as crinoids. Brittle-star fossils may be more spectacular, however, because when they are found as complete or partial specimens, they commonly occur in great numbers. For example, Sass and Condrate (1985) found 12 partial to complete specimens of the Upper Devonian brittle star *Furcaster* in a single exposure of the Alfred Shale in Allegany County, N. Y. Even more spectacular was the occurrence of thousands of specimens of Lower Mississippian *Strataster ohioensis* documented from the silty shales of the Cuyahoga Group at a single outcrop in northern Ohio by Kesling and Le Vasseur (1971).

**ARMED—BUT NOT DANGEROUS.** Based on the few preserved characters that are recognizable, including the arm ossicles that have been distorted through weathering, the Lake Erie fossil belongs to a peculiar group of extinct brittle stars called the encrinasterids. It might even be a species of the type genus *Encrinaster,* which was relatively common in the Late Devonian, but we cannot assign this or any other name with any degree of certainty.

The Lake Erie specimen is oriented on the slab with the mouth side (underside[1]) exposed. In fossil brittle stars, this is the most important side. Details of brittle-star fossils seen from the upper side are relevant but do not provide quite as much information as the underside.

As with all encrinasterids, the arms were petal shaped (wider near the main body and tapering toward the tips) and composed of two sets of ossicles (Figure 3). The innermost ossicles, called *ambulacrals,* were roughly shaped like cowboy boots with the "soles" oriented toward the central body and the "toes" pointing outward. The outermost ossicles, the *adambulacrals,* were composed of relatively thick plates bearing numerous spines. In life, the ambulacrals were the main skeleton of the arms. They bore the water-vascular system, including the tube feet that allowed the animal to move and feed. The adambulacrals functioned as spiked shields that could close over the ambulacrals, thus preventing a predator from getting at the fleshy underside of the arms.

The body, or central disk, of encrinasterids housed the mouth and organs. It was commonly covered with polygonal plates armoring the skin and, in some encrinasterid species (but not this one), it had a ring of

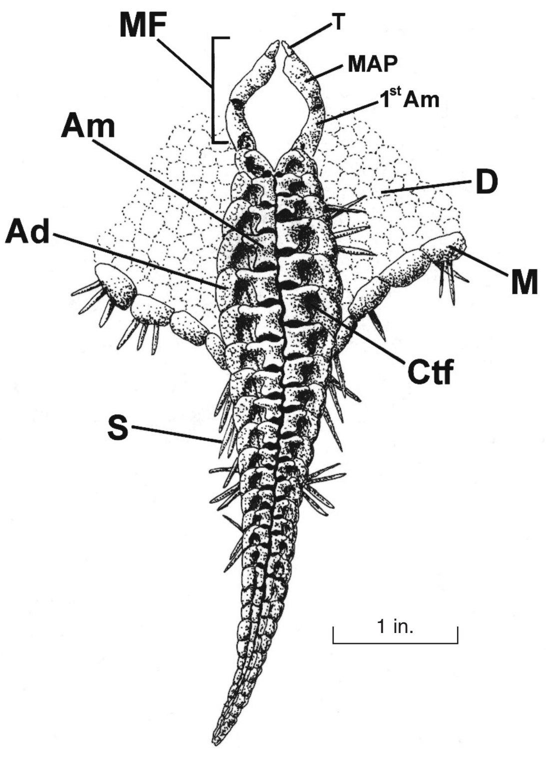



**Figure 3. Reconstruction of one arm of a typical encrinasterid brittle star. MF, mouth frame ossicles, including torus (T), mouth-angle plate (MAP), and first ambulacral (1st Am); Am, ambulacral ossicle; Ad, adambulacral ossicle; D, disk having plates embedded in skin; M, marginal ossicle; Ctf, cup for seating tube feet; and S, spine.**

[1] In standard asterozoan orientation, the mouth is on the underside of the animal. Some brittle stars, however, live buried in the mud with the mouth oriented upward to catch food floating down through the water column. To avoid any undue confusion, we are using standard asterozoan orientation.

stout ossicles around the outer edge to protect the delicate areas between the arms. The recognizable fossilized remains of the Lake Erie brittle star include the mouth frame, 30 ossicles that formed the brittle star's jaws (Figure 3). The fleshy covering of the animal is partially preserved as a dark stain containing a network of small plates, but because of the preservation, it is impossible to tell what they would have looked like in life.

**CONFUSION IN THE RANKS.** Encrinasterid brittle stars and their relatives once were placed in a class (Auluroidea) of the echinoderm subphylum Asterozoa, separate from the three currently accepted classes, Somasteroidea (Figure 4A) (extinct since the Devonian), Asteroidea (Figure 4B), and Ophiuroidea (Figure 4C). Typical sea stars

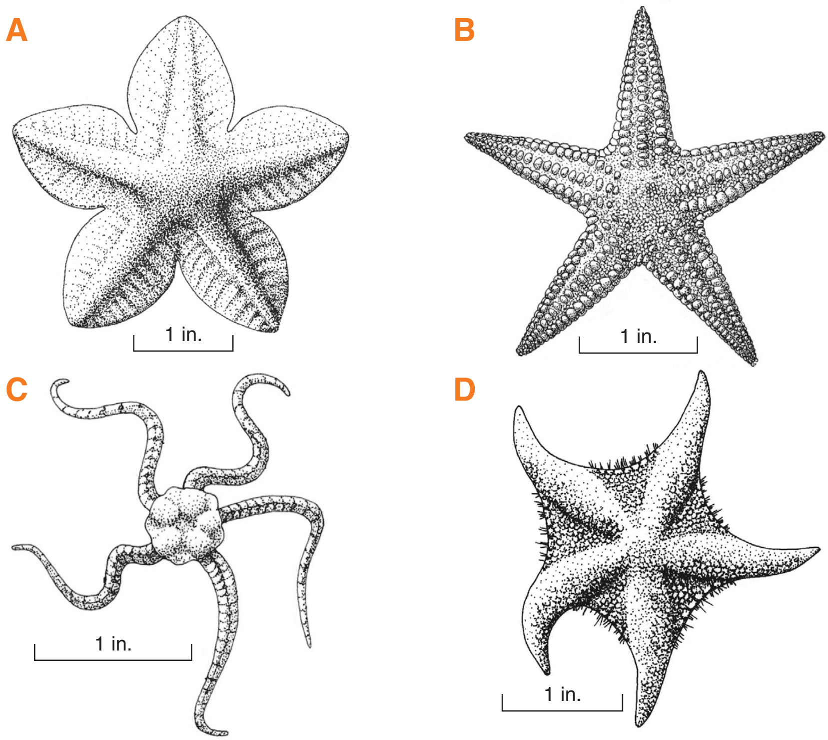



**Figure 4. Comparison of *Encrinaster* with fossil representatives of the three currently accepted asterozoan classes. A. *Villebrunaster,* an Early Ordovician somasteroid (the most primitive group of asterozoans). B. *Devonaster,* a Devonian sea star (typical asteroid). C. *Aganaster,* a Mississippian brittle star (typical ophiuroid). D. *Encrinaster,* a Devonian "auluroid."**

(asteroids) have a fairly rigid star-shaped body plan, whereas typical brittle stars (ophiuroids) have a distinct central disk and five snake-like arms. The group that included the encrinasterids appeared to be about halfway between sea stars and brittle stars (Figure 4D and front cover). This group had arms that could twist and turn somewhat like typical ophiuroids but, because a fleshy sheath enclosed much of the body, the overall shape vaguely resembles that of the true sea star. Schöndorf (1910) designated the class Auluroidea to include asterozoans that had features seemingly midway between "true" sea stars and "true" brittle stars. However, in a classic work on Paleozoic asterozoans, Spencer (1914) demonstrated that auluroids were definitely brittle stars that possessed certain characteristics that indicate the close affinities of sea stars and brittle stars. Thus, although some relatively modern paleontology texts (e.g., Weller, 1969) still include the use of the class name "Auluroidea," it is currently in disfavor. The Lake Erie starfish, in modern taxonomic classification, is definitely an ophiuroid.

**THE AMAZING, UBIQUITOUS BRITTLE STAR.** The geologic record of brittle stars is long, ranging from the Early Ordovician to Recent. Modern brittle stars, which are the most numerous echinoderms today in terms of number of species (2,000, according to Hendler and others, 1995), live in an extremely large variety of marine environments, from shallow lagoons to deep ocean basins. Most ecologists and oceanographers are well aware of the importance of brittle stars in the marine ecosystem—they are a mainstay in the food chains of many marine communities (Fell, 1966). They inhabit a great range of water depths and substrates, and they can tolerate wide ranges of salinity and temperature. Brittle stars are negatively phototropic—a fancy way of saying they do not like light—so they tend to hide in burrows or on the undersurfaces of overhanging rocks during the day.

Different brittle stars eat different things in different ways. Those that eat tiny swimming animals or organic debris drifting down through the water column catch the food with the tube feet lining their arms, then pass their arms over their mouths. Some actively prey on small bottom-dwelling animals such as worms, clams, crustaceans, and other echinoderms. Many are scavengers, eating any organic debris they find while combing the sea floor, including dead fish. Still others are detritus feeders, picking nutrient particles out of the mud or the water column with their tube feet. Some brittle stars live in close association with corals, sponges, or crinoids, whereas others live a burrowing existence in soft muddy or sandy bottoms, coming out of their holes at night in search of food. Many examples of these types of behavior have been inferred from the fossil record as well.

**LIFE AT THE BOTTOM.** Because they lived on (or in) almost any kind of sediment substrate, fossil brittle stars have been found in almost every kind of sedimentary rock. The best-preserved fossils, however, have been found in the dark-colored, organic-rich shales and siltstones of the Ordovician and Devonian, such as the Middle Devonian Hamilton Group of New York and the Upper Ordovician Martinsburg Formation of central Pennsylvania. The famous Swatara Gap fossil locality in Lebanon County, Pa., is an example of a location in the Martinsburg that, over the years, supplied collectors with hundreds, if not thousands, of specimens of *Palaeasterina* (another encrinasteridlike brittle star). Brittle stars are also relatively common in the Lower Devonian Hunsrück Slate of Bundenbach, Germany (Lehmann, 1957), where, in many cases, the calcareous ossicles of these animals have been replaced by pyrite, providing excellent preservation (Sutcliffe, 1997). This phenomenon has even allowed the use of X-radiography, which enables paleontologists to view the fossils that are still completely encased in the rock. The undisturbed sediments found in quiet bottom waters where oxygen starvation (anoxia) can occur on a regular basis are especially conducive to the preservation of delicate or soft-bodied creatures. A brittle star found in the Pennsylvanian Brush Creek black shale near Punxsutawney in Jefferson County, Pa., actually had part of the water-vascular system preserved by pyrite or some other sulfide mineral (Harper and Morris, 1978).

The Lake Erie specimen is a good example of a brittle star that lived on a muddy sea floor. When it was deposited about 365 million years ago, the Northeast Shale was most definitely mud. The formation typically is nondescript gray shale having thin interbeds of gray siltstones and abundant trace fossils ("fucoids" of nineteenth-century authors). However, it contains, at best, only a few unremarkable fossil shells, mostly brachiopods. In fact, the Northeast Shale is characterized by its overwhelming lack of good fossils other than trace fossils. Periodic or continuous influxes of mud and silt from river systems to the southeast of Erie County would have clogged the respiratory organs of most bottom-dwelling shellfish and buried any slow-moving organism foolish enough to try establishing a habitat on or just below the sea floor. Only mobile burrowers such as worms would have found this a profitable area in which to take up residence, especially if the water and mud were rich in organic detritus. Therefore, an enterprising brittle star, eager to dig a shallow burrow in which it could hide and feed, and quick enough to escape rapid burial, would find this an almost ideal setting. The biggest drawback would have been probable episodes of stagnation and anoxia that would have killed everything except anaerobic bacteria at or near the sediment-water interface.

If the Lake Erie shale slab was found approximately in the correct orientation, that is, with its top side up, then the brittle star was buried with its mouth side up. Considering the excellent preservation of the fossil (before weathering), the animal would have been buried in approximate life position. This suggests that it lived within a shallow burrow with just the ends of its arms sticking out of the mud to collect organic debris suspended in the water column. The fact that most of the animal's arms are missing on the specimen lends credence to this supposition—if most of the arms were oriented upward at death, they would have been eroded or split off when the shale slab was eroded from the Lake Erie bluff.

Under the circumstances, it is interesting that no other brittle stars have been reported from the Northeast Shale. Perhaps some diligent searching in areas where the formation contains incipient or fully formed concretions will reveal more and better specimens of these fascinating creatures.

## REFERENCES


Fell, H. B., 1966, The ecology of ophiuroids, chap. 6 *of* Boolootian, R. A., ed., Physiology of Echinodermata: New York, Wiley Interscience, p. 129–143.

Harper, J. A., and Morris, R. W., 1978, A new encrinasterid ophiuroid from the Conemaugh Group (Pennsylvanian) of western Pennsylvania, and revision of the Encrinasteridae: Journal of Paleontology, v. 52, p. 155–163.

Hendler, Gordon, Miller, J. E., Pawson, D. L., and Kier, P. M., 1995, Sea stars, sea urchins, and allies—Echinoderms of Florida and the Caribbean: Washington, D. C., Smithsonian Institution Press, 390 p.

Kesling, R. V., and Le Vasseur, Douglas, 1971, *Strataster ohioensis;* a new Early Mississippian brittle star, and the paleoecology of its community: Ann Arbor, University of Michigan Museum of Paleontology Contributions, v. 23, no. 20, p. 305–341.

Lehmann, W. M., 1957, Die Asterozoen in den Dachschiefern des rheinischen Unterdevons: Abhandlungen des Hessischen Landesamtes für Bodenforschung, v. 21, 160 p.

Sass, D. B., and Condrate, R. A., 1985, Destruction of a Late Devonian ophiuroid assemblage—A victim of changing ecology at the Catskill delta front, *in* Woodrow, D. L., and Sevon, W. D., eds., The Catskill delta: Geological Society of America Special Paper 201, p. 237–246.

Schöndorf, Friedrich, 1910, Paläozoische Seesterne Deutschlands—II, Die Aspidosomatiden des deutschen Unterdevon: Palaeontographica, v. 57, p. 1–63.

Spencer, W. K., 1914, British Palaeozoic Asterozoa, Part I: Palaeontographical Society of London Monograph, v. 1913, p. 3–33.

Sutcliffe, O. E., 1997, An ophiuroid trackway from the Lower Devonian Hunsrück Slate, Germany: Lethaia, v. 30, p. 33–39.

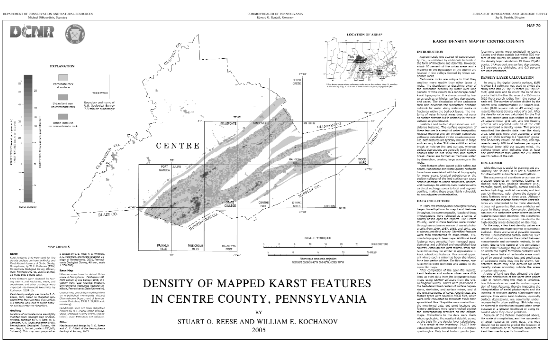
Weller, J. M., 1969, The course of evolution: New York, McGraw-Hill, 696 p.

# Karst Density Map for Centre County

The Bureau of Topographic and Geologic Survey recently released its second formal, “web-only” map publication. **Map 70, Density of Mapped Karst Features in Centre County, Pennsylvania,** by Bureau geologists Stuart O. Reese and William E. Kochanov, is available as a free download on the Survey web site at **www.dcnr.state.pa.us/topogeo/map70.** Like its predecessor, Map 68 (see *Pennsylvania Geology,* v. 33, no. 3, p. 20), Map 70 shows the density of known karst features relative to areas of carbonate rock. The brightly colored, 1:300,000-scale map was created by Reese using ESRI ArcMap software and exported at 600 dpi to a PDF file, which has a size of 2.28 MB. When plotted full size, Map 70 is 25 by 16 inches.

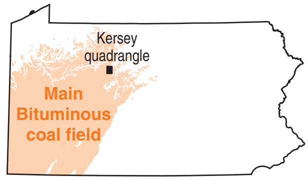
Gradational green-through-red colors on Map 70 indicate the density of the central points of karst features that were mapped at 1:24,000 scale by Kochanov. The Bureau published these maps in 1992 as Open-File Report 92–01, *Sinkholes and Karst-Related Features of Centre County, Pennsylvania.* In all, 24,657 data points were compiled for the county.

Map 70 includes a text discussion on karst features, data collection procedures, density layer calculations, and proper use of the map. Karst terrains are commonly associated with damages that occur to buildings, utilities, and roads when the underlying earth surface gives way, and they represent areas vulnerable to groundwater contamination. It is important to note that although this publication is useful for regional planning and preliminary site studies, it is not a substitute for site-specific subsurface investigations.




**Grayscale image of Map 70 greatly reduced in size. The colors of the original map cannot be displayed here.**

# Kersey Quadrangle Coal-Resource Maps and Digital Datasets

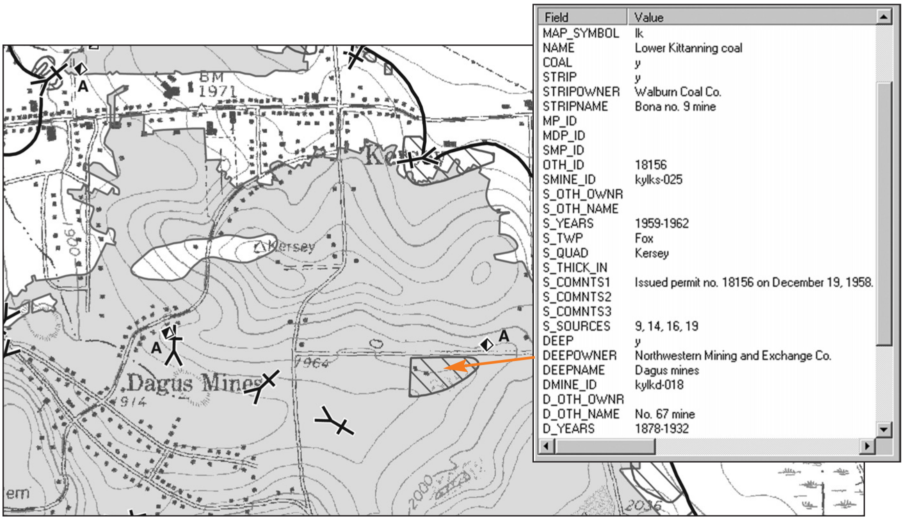



The Bureau of Topographic and Geologic Survey announces the release of Mineral Resource Report 100, **Bedrock Geologic Map, Coal-Resource Maps, and Digital Datasets of the Kersey Quadrangle, Elk and Clearfield Counties, Pennsylvania,** by staff geologist Clifford H. Dodge. This publication is the second digital coal-resource report to be published by the Bureau on CD–ROM, following the release of the report on the Brandy Camp quadrangle (see *Pennsylvania Geology,* v. 34, no. 1, p. 12–14).

The Kersey report provides information on the areal bedrock geology, structural geology, coal resources, and extent of past surface and underground coal mining for an important area in the Main Bituminous coal field not previously studied in detail. It contains both graphic images (mostly maps) that can be printed by the user and digital datasets (coverages), which can be employed for spatial analysis and other geographic-information-system applications and for preparation of customized hardcopy maps. A brief text is included as well.

The 11 graphic images (plates) include a colored geologic map and two kinds of coal-resource maps at a scale of 1:24,000. (Page-sized versions of the plates are also provided.) The colored geologic map shows the distribution of the bedrock formations and selected key beds that are not coals; structure contours, fold axes, and fault; and locations of selected data points. Included on the map plate are a correlation diagram and description of map units, a representative columnar section of the coal measures, and a cross section.

The coal-resource maps include (1) a composite map, showing outcrops (crop lines) of all the coals identified, structure contours, fold axes, and fault, and (2) separate maps for each principal (commercial) coal bed, showing the crop line (where coal is present or was present before mining), horizon line (projected or estimated outcrop position where coal is absent due to erosion or nondeposition), fault, and extent of all known surface and underground mining. Color-coded inset maps on the separates show the areal extent and types of mining and the relative distribution of the remaining coal. The separate maps also depict the locations of all known adits and mine shafts.



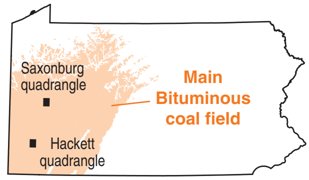

A portion of a coal-resource map (1:24,000 scale) from the Kersey report, showing crop lines, abandoned adits and shafts, and mined-out areas on the Lower Kittanning coal. Some of the information in the dataset for the indicated area is displayed on the right. The colors of the original map cannot be shown here.

Digital files include a series of vector datasets containing polygon, line (arc), and point feature classes, and raster datasets consisting of collarless georeferenced images of the plates. The vector datasets include bedrock geologic units, mined areas for each economic coal, structure contours, folds, economic coal beds, noneconomic coal beds, selected key beds that are not coals, adits and mine shafts, and selected data points (drill holes, field stations, gas wells, and water wells).

The information in this report will be of considerable help in exploration programs, coal-resource assessments, hydrogeological investigations, land acquisition, land-use planning, and environmental protection and regulation.

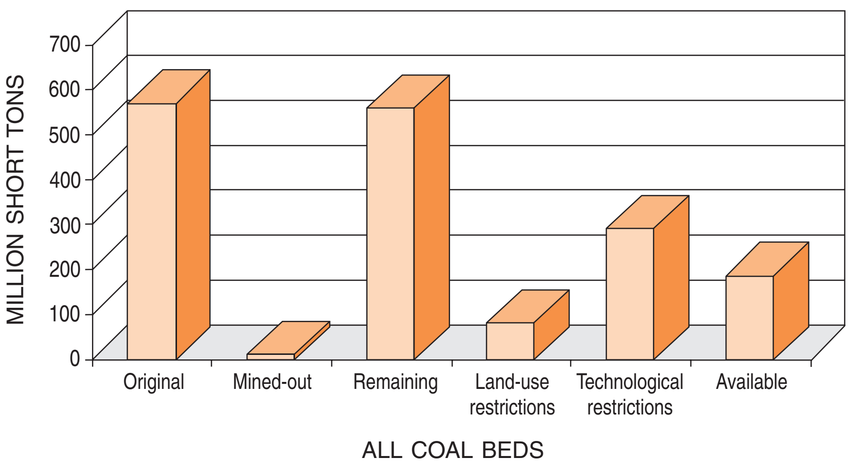
**Mineral Resource Report 100** costs **$5.00** and is available from the State Bookstore, Commonwealth Keystone Building, 400 North Street, Harrisburg, PA 17120–0053, telephone 717–787–5109. Payment may be made with VISA, MasterCard, or check or money order payable to *Commonwealth of Pennsylvania.* If the order is to be mailed, include **$4.00 postage** for one and **$0.50** for each additional CD–ROM. For over-the-counter orders and orders sent to a Pennsylvania address, **6 percent sales tax** must be added to the total cost of the order, including postal charges. The report can also be purchased (by check or money order) over the counter at the Bureau's Middletown office (see address on back cover).

# Coal Availability Studies for Saxonburg and Hackett Quadrangles




Two coal availability studies in the Main Bituminous coal field of Pennsylvania have been published by the Bureau of Topographic and Geologic Survey as open-file reports. OF 05–01, **A Study of Coal Availability in the Hackett 7.5-Minute Quadrangle, Washington County, Pennsylvania,** and OF 05–02, **A Study of Coal Availability in the Saxonburg 7.5-Minute Quadrangle, Butler County, Pennsylvania,** by staff geologists Leonard J. Lentz and John C. Neubaum, consist of text and map figures. They are accessible on the Bureau's web site from the list of open-file reports **(www.dcnr.state.pa.us/topogeo/pub/openfile.aspx).**

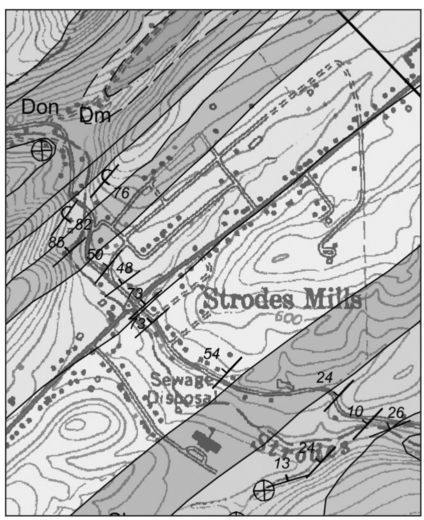
The studies were supported by grants from the U.S. Geological Survey. The authors made use of geographic-information-system technology to compare areas of original coal to areas where coal had been mined and areas where mining is restricted. Comparisons were made for all economic coal beds in the quadrangles. The authors considered the present areas of coal, coal thicknesses, and restrictions to estimate the available coal resources for each quadrangle.




**Graph showing the availability of coal in the Saxonburg quadrangle. Figure is modified from the cover of OF 05–02.**

# Series of Bedrock and Surficial Maps Made Available Online

In 2005, the Bureau of Topographic and Geologic Survey released two surficial and eight bedrock geologic maps as parts of two series of online open-file reports (OFSM and OFBM, respectively). The reports were done under the STATEMAP component of the U.S. Geological Survey's National Cooperative Geologic Mapping Program, which currently funds bedrock mapping in the Lewistown area of central Pennsylvania, bedrock mapping in the Piedmont of southeastern Pennsylvania, and surficial mapping in the Williamsport East 30- by 60-minute quadrangle in northeastern Pennsylvania. The recently released reports and their authors are as follows: OFSM 05–01.0, **Surficial Geology of the Hillsgrove 7.5-Minute Quadrangle, Sullivan and Lycoming Counties, Pennsylvania,** by Duane D. Braun, Bloomsburg University; OFSM 05–02.0, **Surficial Geology of the Eagles Mere 7.5-Minute Quadrangle, Sullivan County, Pennsylvania,** by Duane D. Braun; OFBM 05–01.0, **Preliminary Bedrock Geologic Map of a Portion of the Wilmington 30- by 60-Minute Quadrangle, Southeastern Pennsylvania,** compiled by Gale C. Blackmer, Pennsylvania Geological Survey; OFBM 05–02.0, **Bedrock Geologic Map of the Lansdowne and Pennsylvania Portion of the Bridgeport Quadrangles, Delaware, Montgomery, and Philadelphia Counties, Pennsylvania,** by Howell Bosbyshell, West Chester University; OFBM 05–03.0, **Bedrock Geologic Map of the Unionville Quadrangle, Chester County, Pennsylvania,** by C. Gil Wiswall, West Chester University; OFBM 05–04.0, **Map of the Bedrock Geology South of the Brandywine Manor Fault, Honey Brook Quadrangle, Lancaster and Chester Counties, Pennsylvania,** by Carolyn H. Brown, State Map Cooperator, Pennsylvania Geological Survey; OFBM 05–05.0,




Grayscale image of a portion of the bedrock geologic map for the Belleville quadrangle (OFBM 05–07.0). The colors of the map cannot be shown here.

**Map of the Bedrock Geology, Wagontown Quadrangle, Chester County, Pennsylvania,** by L. Lynn Marquez, Millersville University; **OFBM 05–06.0, Bedrock Geologic Map of the Pennsylvania Portion of the Marcus Hook Quadrangle, Delaware County, Pennsylvania,** by Howell Bosbyshell; **OFBM 05–07.0, Bedrock Geology of the Belleville Quadrangle, Mifflin County, Pennsylvania,** by Thomas A. McElroy and Donald M. Hoskins (retired), Pennsylvania Geological Survey; and **OFBM 05–08.0, Bedrock Geology of the Barrville Quadrangle, Centre, Huntingdon, and Mifflin Counties, Pennsylvania,** by Arnold G. Doden, GMRE, Inc., State College, Pa. The specific areas covered by each report are shown on the back cover.

In addition to the maps, each report includes associated geographic-information-system data and descriptions of the map units (map text). To view or download the maps and data, go to the appropriate links under the open-file list at **www.dcnr.state.pa.us/topogeo/pub/openfile.aspx.**

# Two Topical Open-File Reports for Pennsylvania Released in 2005

The Bureau of Topographic and Geologic Survey recently released two online open-file reports that address issues on a statewide basis. **Open-File General Geology Report 05–01.0, Basement Depth and Related Geospatial Database for Pennsylvania,** was compiled by S. S. Alexander and R. Cakir of the Pennsylvania State University (PSU); A. G. Doden of GMRE, Inc., State College, Pa.; David P. Gold of PSU; and S. I. Root of the College of Wooster, Ohio. The report includes a PDF file of a 1:500,000-scale Precambrian basement map of the state, a text, and the data (or links to data) used to prepare the map. The map shows basement structure, generalized rock units, and data points. In the text, the authors suggest other thematic maps that could be produced from the data layers.

The other new release, **Open-File Miscellaneous Investigation Report 05–01.0, Geologic Units Containing Potentially Significant Acid-Producing Sulfide Minerals,** was developed with the cooperation of two other state agencies: the Department of Environmental Protection and the Department of Transportation. The 1:500,000-scale map for this report shows rock units that are potential sources of acid drainage and includes related data layers, such as streams adversely affected by abandoned-mine drainage.

The reports can be accessed from the web site given above.

ANNOUNCEMENT

# Don’t Delay—Buy Now!

## *Many Bureau Publications in Low Supply*

The Bureau publications listed below are in critically low supply and will not be reprinted in hard-copy form. Complete bibliographic information for each item can be found at **www.dcnr.state.pa.us/topogeo/pub/pgspub.aspx.**

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Publications may be purchased from the State Bookstore. See page 12 for payment, postage, and tax information. Requests are processed in the order they are received, and there is no guarantee that any particular item listed above will still be available when your order is placed.

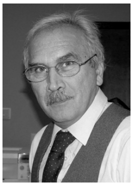
# A Salute to Retired Staff

In the last four years, we have said goodbye to seven long-term staffers. Together, they served the state for more than 200 years!

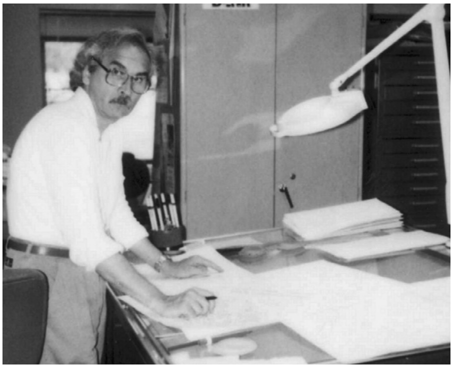
## LAJOS J. BALOGH

**Cartographic Drafter**

34 Years State Service
Retired 6/27/03



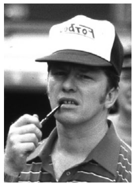
Lajos spent more than 34 years as a cartographic drafter with the Pittsburgh office of the Pennsylvania Geological Survey. During his tenure, Lajos drafted numerous maps, cross sections, and a variety of other illustrations for Survey publications and displays, professional journals, and professional talks. He could often be seen hunched over a light table, a magnifying visor on his head, meticulously measuring and inking or scribing lines. Lajos was primarily responsible for drafting and updating the Survey's 600-plus oil and gas well base maps. He displayed great skill and artistic talent in his work, and his enormous patience and extensive knowledge of maps allowed him to spot difficult well locations with ease.



## LESLIE T. CHUBB

**Laboratory Technician**

34 Years State Service
Retired 6/24/04



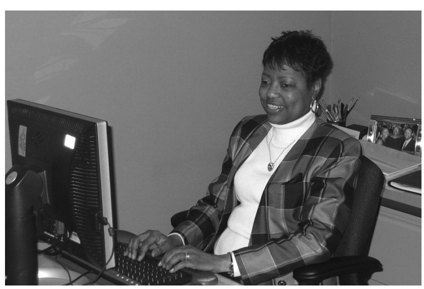
Les started at the Survey as a laboratory technician in 1970 and was already familiar with our operations when we experienced the twin traumas of a flood and a move in 1972. During his time with us, Les was to help the Survey survive seven moves, every one of which would have been much more difficult without his organizational talents. Thanks to Les, our laboratories were safe, clean, and well-organized, and the equipment was properly maintained. Always ready to learn, Les developed a proficiency at many geological laboratory skills, including X-ray diffraction identification of minerals, various mineral-concentration techniques, and complex procedures used to ready samples for outside analyses or thin-section preparation. Whenever something needed to be done, whether in the lab, office, or field, Les could be counted on to pitch in. We wish him a long and happy retirement.

## CHERYL L. COZART

**Information Technology Administrator**

37 Years State Service
Retired 6/24/05

Cheryl retired from the Survey in June 2005 after more than 37 years of service in the Pittsburgh office. However, in typical fashion, she was not content to just leave. She remains on staff through April 2006 as an annuitant to oversee the continuing development and administration of our database systems, and to mentor her replacement. Cheryl began her career with the Survey as a stenographer and worked her way up to Information Technology Administrator. Along the way, she initiated, developed, and maintained the Survey's major databases, including the Wells Information System and the Pennsylvania Internet Record Imaging System (PA*IRIS), which are indispensable to the oil and gas industry. Most recently, Cheryl has been instrumental in the initial development of our stratigraphic database. Cheryl's positive attitude and hard work have made her an asset to the Survey and a joy to her fellow workers.



## JAMES H. DOLIMPIO

**Cartographic Drafter**

31 Years State Service
Retired 7/12/02

Jim came to the Survey from the Pennsylvania Department of Transportation in 1980 to work as a cartographic drafter. He started in an age of pen and ink, transfer lettering, scribers, and peelcoats, and ended in an age of computer-aided drafting and georeferencing. Through it all, he was patient, polite, and almost always smiling. Jim can be recognized for his expert drafting of numerous types of complex maps: mineral resource, coal resource, surficial and bedrock geologic, environmental, water resource, and others. He also drew thousands of illustrations, both technical and nontechnical, for many of our publications, including this magazine. In addition to his excellent cartographic work for publications, Jim cheerfully assisted staff with figures and posters for outside journals and conferences. Whatever his assignment, Jim took great pride in his work and made a significant and lasting contribution to our Survey products.

## JON D. INNERS

**Geologist Manager**

33 Years State Service
Retired 6/25/04

Jon came from the Pennsylvania Department of Transportation to the Survey in 1973 as a geologist in the Geologic Mapping Division. In 1989, he became chief of that division. While employed at the Survey, Jon spent much of his time mapping in the Ridge and Valley province. Jon is never more enthusiastic than when he is in the field, and he shares his enthusiasm with those around him. He was a leader for seven of the Annual Field Conferences of Pennsylvania Geologists, and he will be involved in two of the next three. He has been an author or coauthor of numerous technical and popular Survey reports. Jon's enthusiasm for geology is complemented by his love for military history and industrial archaeology. He has written on such diverse topics as iron furnaces and the geology of battlefields.

In his retirement, Jon continues to pursue his passion for geology, spending much of his time studying bedrock and glacial geology in Susquehanna County, Pa.

## JOHN G. KUCHINSKI

**Cartographic Draftsman Supervisor**

33 Years State Service
Retired 12/23/03

Jack started at the Survey in 1969 as a cartographic drafter and was promoted to a supervisory position in 1985. He spent his earlier years preparing mylars, scribers, and peelcoats for hundreds of illustrations and complex maps published by the Survey, including the 1980 *Geologic Map of Pennsylvania*. In his later years at the Survey, Jack produced maps and illustrations on the computer using graphics and geographic-information-system software. The mark of his skill and craftsmanship can be found in every one of our publication series and in past issues of this magazine. Jack was known for his accurate work, but he was also known for his great sense of humor and infectious laugh. His humor, along with his artistic talents, made for some memorable celebration posters. It also made for some hidden treasures. In a "Where's Waldo" style, Jack would hide his initials in some of his work, making them, like him, one of a kind.

## ROBERT C. SMITH, II

**Geologist Supervisor**

33 Years State Service
Retired 6/24/05

Bob joined the Survey early in 1972 as a geochemist, just in time to demonstrate his energy and ingenuity in the recovery efforts of our flooded Harrisburg office. When he was able to settle into his real work, Bob quickly became known for his expertise in both the field and the laboratory. He was called upon constantly by agencies and individuals to interpret a variety of geologic data. For example, Bob helped the commonwealth deal with numerous environmental issues. He did extensive research documenting and understanding the occurrence of radioactive minerals in the Reading Prong. Many of his accomplishments are chronicled in his publications, including a multitude of Survey reports and the exemplary *The Mineralogy of Pennsylvania, 1966–1975,* published by the Pennsylvania Chapter of the Friends of Mineralogy. In retirement, Bob continues his geologic explorations and remains a walking encyclopedia of geologic and mineralogic knowledge.

DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES

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IN COOPERATION WITH THE U.S. GEOLOGICAL SURVEY
TOPOGRAPHIC MAPPING
GROUNDWATER-RESOURCE MAPPING

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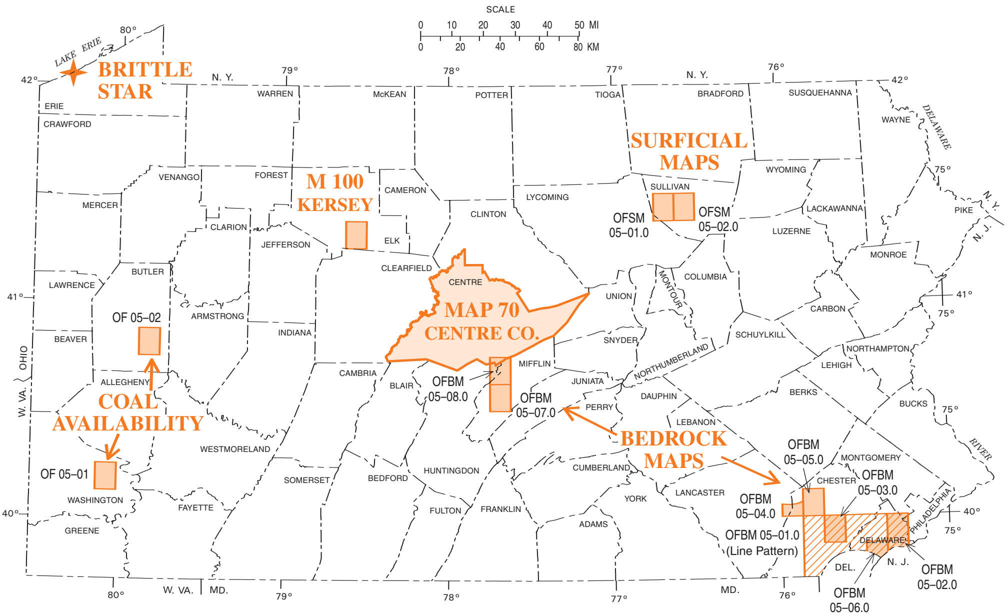



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