GEOLOGIC STRUCTURE OF NEAR-SURFACE ROCKS IN WESTERN OHIO[1]

STANLEY E. NORRIS

U.S. Geological Survey, Water Resources Division, Columbus, Ohio 43212

ABSTRACT

NORRIS, STANLEY E. Geologic structure of near-surface rocks in western Ohio. Ohio J. Sci. 75(5): 225, 1975.

A geologic structure map on the Silurian-Age Lockport Dolomite in western Ohio is presented. The map, compiled from recently published ground water reports, is expected to be useful in a variety of geologic applications.

In 1970 the Ohio Department of Natural Resources, in cooperation with the U.S. Geological Survey, completed an investigation of the limestone and dolomite aquifers in an area of about 9,000 square miles (23,310 square kilometers) in northwestern Ohio. The main part of the investigation involved the drilling, testing, and geophysical logging of approximately 80 exploratory wells, ranging in depth from about 200 feet to more than 400 feet (61 to 122 meters). Thirty-five municipal and industrial water wells also were logged. The logging program consisted of making natural gamma, single-point resistance, self-potential, and caliper logs, using portable, hand-operated equipment. Early in the investigation it became evident that the geophysical logs, especially the natural gamma logs, provided a basis for identifying the carbonate-rock units and determining the position of the contact between the Silurian-Age Lockport Dolomite and the overlying Silurian rocks (Norris and Fidler, 1969). A structure contour map on the top of the Lockport Dolomite was constructed, based on the data from the water well logs, plus a few scattered control points determined directly from quarry exposures, and agumented with data from approximately 85 natural gamma logs of oil and gas wells made by commercial logging companies (see Norris and Fidler, 1971, fig. 2).

After completion of the work in northwest Ohio, the water-resources investigation was extended into the southwest and central parts of the State, where 53 additional wells were drilled and logged. Data from these wells, supplemented by data from a nearly equal number of commercial oil and gas well logs and the logs of about 10 municipal and industrial wells, were used to construct a similar structure contour map essentially covering the remainder of the area of occurrence of the limestone and dolomite deposits in western Ohio (see Norris and Fidler, 1973, fig. 2).

The maps in previous reports, showing in considerable detail the geologic structure of the near-surface rocks in western Ohio, proved useful in defining the aquifer framework and determining the availability of ground water in a large region where limestone and dolomite aquifers are important sources of water supply. They should be of value also to those concerned with geologic problems not associated with water-resources evaluation. To further enhance the utility of the maps, they are combined in the present report into one map covering the entire area studied in western Ohio.

The new map (fig. 1) presents a brief description of the principal carbonate-rock units and structural features in western Ohio, chiefly abstracted from the above-referenced reports. The reader is referred to those reports, and references cited therein, for more complete information on the carbonate rocks and an explanation of how the geophysical logs were interpreted.

STRATIGRAPHY

Silurian-age carbonate rocks consisting chiefly of the Lockport Dolomite and the overlying Bass Islands Group (chiefly dolomite) underlie most of the relatively flat terrain of western Ohio, where they crop out or lie beneath glacial deposits

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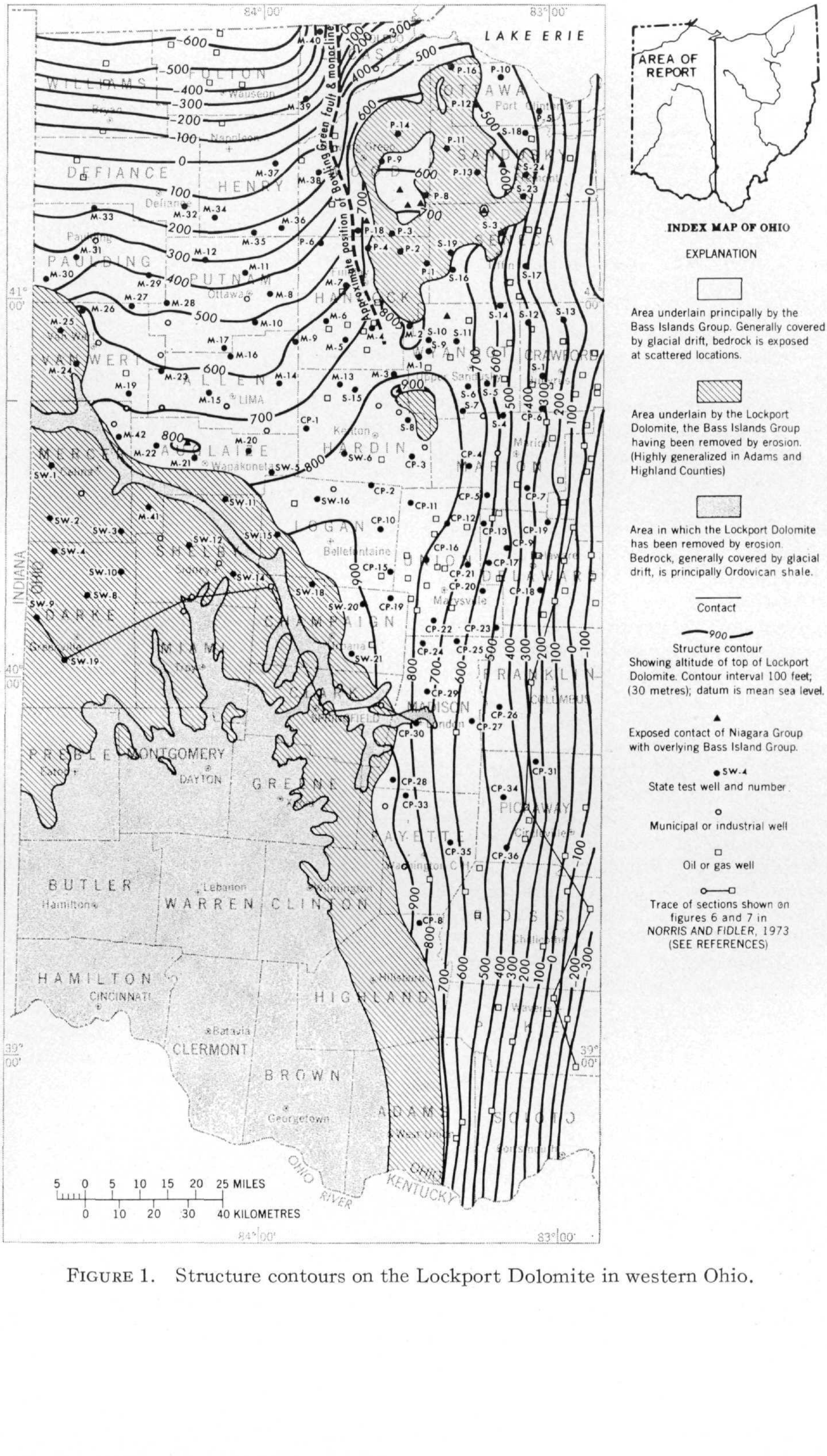

FIGURE 1. Structure contours on the Lockport Dolomite in western Ohio.

having a wide range in thickness. Locally in parts of Logan and Champaign Counties and more generally in counties in the central part of the State, the Bass Islands Group is overlain by Middle Devonian limestone (Columbus and Delaware limestones) and shale. In the northwest corner of the State, in Williams, Fulton, and parts of Defiance and Henry Counties, carbonate rocks are too deeply buried by glacial deposits and the Ohio Shale of Late Devonian age to be a common source of water to wells.

The Lockport is an exceptionally pure, light-gray to white, finely to coarsely crystalline dolomite, typically occurring in beds ranging in thickness from about 1 to 5 feet (0.3 to 1.5 m). Locally, it grades into reeflike masses, with little or no discernible bedding. The change from normal bedding to the reeflike phase is accompanied by a large increase in thickness; it is believed that reefs characterize the unit wherever it is more than about 100 (30 m) thick.

The overlying Bass Islands Group in Ohio consists generally of a thinly bedded, brown-to-drab, crystalline-to-granular, argillaceous dolomite. The Bass Islands group includes, in ascending order, the Greenfield Dolomite, Tymochtee Formation, Put-in-Bay Dolomite, and Raisin River Dolomite. These dolomite units are generally distinguishable from one another on the outcrop; however, there is much variation in lithology from place to place. Carman (1927, p. 485) states that although rocks fitting the general description of the Bass Islands Group can be found in all the constituent units, "each member also has one or more other types of stone within it. There are zones of massive permeable dolomite, of evenly bedded nonlaminated dolomite, of brecciated dolomite, of dolomitic shale, of limestone, and of gypsum."

STRUCTURE

The consolidated rocks were raised by tectonic forces to form the broad, low Cincinnati arch, a major structural feature of the mid-continent region. Extending northward from the Nashville dome area in Tennessee to a terminus in southern Ontario, the Cincinnati arch separates the Appalachian basin on the east from the Illinois and Michigan basins on the west and northwest. As indicated by contours in figure 1, the axis of the Cincinnati arch in western Ohio extends from southwest to northeast, from Cincinnati approximately through Dayton, Bellefontaine, and Kenton to a point near the western end of Lake Erie. The carbonate beds are nearly flat lying on the top of the arch, for example in Logan County and southeast Hardin County, and dip away at low angles on both flanks. In the northwest part of the study area, the dip of the Lockport Dolomite on the west side of the arch is to the north and northwest at 5 to 10 feet per mile (1 to 2 m/km). On the east side of the arch, the dip of the Lockport Dolomite is somewhat steeper, about 25 feet per mile (4.7m/km) along a line extending from east-central Champaign County into Franklin County.

Associated with the western flank of the Cincinnati arch in Hancock, Wood, and Lucas Counties is the north-trending Bowling Green fault and monocline, the approximate position of which is shown on the map. Evidence obtained in this investigation is insufficient to define accurately the position and magnitude of the fault. The relatively few control points shown on figure 1 in the immediate vicinity of the fault were useful chiefly in making minor changes in its position, the general location of which is that described by Stout (1941, p. 15–16). Stout traced the location of the fault southward from Michigan to Hardin County on the basis of data from oil and gas wells. The fault is downthrown on the west side; the maximum displacement, according to Stout (1941, p. 16), is about 200 feet (61 m) in the vicinity of Bowling Green, in Wood County. The Bowling Green fault is known to be exposed at only one place in western Ohio near a quarry in the vicinity of Waterville, in southern Lucas County. According to J. E. Carman (1948), north of the Waterville quarry the rocks along the extenstion of the Bowling Green fault are no longer displaced relative to one another, but become a steeply dipping monocline.

Erosion reduced the consolidated rocks along the top of the arch to a generally even plain, exposing progressively older rocks in a southwesterly direction. The carbonate beds were removed by erosion in the southwestern quarter of the State in an area of approximately 3,700 square miles (9,583 km^2), leaving exposed, or thinly covered by glacial drift, a thick sequence of thinly bedded shale and shaly limestone strata of Ordovician age (see fig. 1).

Peripheral to this area of Ordovician rocks—and to a relatively narrow strip underlain by older Silurian rocks, chiefly the Brassfield Limestone—the Lockport Dolomite constitutes the bedrock in an irregular band, underlying approximately 4,000 square miles (10, 360 km^2) in all or parts of 17 counties. The outcrop band is narrowest in the southern part of the study area, near the Ohio River in central Adams County, and widest in the western part of the study area, where it is found throughout virtually all of Darke, Mercer, and Shelby Counties and significant parts of adjacent counties. The Lockport Dolomite is also exposed or thinly covered by glacial drift, along the crest of the arch in the northern part of the area, chiefly in Hancock, Seneca, Wood, Ottawa, and Sandusky Counties.

Adjacent to the outcrop area of the Lockport Dolomite, the Bass Islands Group, a wedge-shaped sequence of carbonate beds, constitutes the bedrock in most of the remainder of western Ohio in an area of about 8,200 square miles (21,238 km^2).

The carbonate beds as a whole thicken on both sides of the arch in the direction of dip. The aggregate thickness of the entire carbonate sequence ranges from near zero at the outcrop in western Ohio to (about) 600 feet (183 m) at Columbus, where it includes approximately 130 feet (40 m) of Devonian-age Columbus and Delaware limestones. In the northwest part of the State the carbonate rocks, including Devonian-age units, are believed to reach a maximum thickness of 800 to 900 feet (244 to 275 m).

Structural relief along the crest of the arch is in part a depositional feature resulting from an increase in the thickness of the Lockport Dolomite where reefs occur. Typically 180 to 200 feet (55 to 61 m thick in northwest Ohio, the Lockport Dolomite thickens markedly near the northern end of the arch where Sparling (1965, p. 236) reported the thickness to be more than 400 feet (122 m) in a quarry test hole in Ottawa County. The unit thins southeastward, beneath a thickening cover of younger rocks, to about 65 feet (20 m) near London, in Madison County, where the top of the unit at the site of State test well CP-30, occurs at a depth of 261 feet (80 m).

LITERATURE CITED

Carman, J. E. 1927. The Monroe division of rocks in Ohio. Jour. Geology 35: 481–506.

——— 1948. A study of the geology of Lucas County and the lime-dolomite belt. Ohio Adacemy of Science, Annual Field Conf. in Geology, p. 6 (mimeo.).

Norris, S. E., and R. E. Fidler. 1969. Correlation of carbonate rock units in northwest Ohio by natural gamma logging, *In* Geological Survey Research 1969. U.S. Geol. Survey Prof. Paper 650-B, B158–B161.

——— 1971. Availability of ground water from limestone and dolomite aquifers in northwest Ohio and its relation to geologic structure, *In* Geological Survey Research 1971. U.S. Geol. Survey Prof. Paper 750-B, p. B229–B235.

——— 1973. Availability of ground water from limestone and dolomite aquifers in southwest Ohio and the relation of water quality to the regional flow system. U.S. Geol. Survey Water Resources Invest. 17–73.

Sparling, D. R. 1965. Geology of Ottawa County, Ohio. Ohio State Univ., unpub. Ph.D. thesis. 265 p.

Stout, Wilber. 1941. Dolomites and limestones of western Ohio. Ohio Geol. Survey Bull. 42, 4th ser., 468 p.