Geologic Overview and Activity Update for the Utica-Point Pleasant Shale Play in Ohio

Lawrence H. Wickstrom, Ronald A. Riley, Matthew S. Erenpreiss, and Christopher J. Perry
Ohio Department of Natural Resources, Division of Geological Survey ▫ 2045 Morse Rd., Bldg. C-1, Columbus, OH 43229-6693

Regional Stratigraphy and Structure

During Trenton/Lexington depositional time effects, of the ensuing Taconic Orogeny were manifested by way of a distal bulge developing over the northwest-Ohio area, leading to a clean carbonate platform. Closer inboard to the collision zone the Lexington Platform developed centered over the Kentucky-West Virginia area as well as a central New York platform. Trenton/Lexington carbonate thickness ranges from over 200 ft on the Trenton Platform in northwestern Ohio to more than 300 ft on the Lexington Platform in central Kentucky, and to over 850 ft on the Trenton Platform in central New York (fig. 5). A large, interplatform sub-basin developed between these in which interlayered organic-rich shale and carbonates were deposited (figs. 6–8). Eventually, sea level rise associated with the orogeny overwhelmed all of the carbonate platforms, and the Utica Shale was deposited over most of the carbonate platforms as well as on top of the Point Pleasant within the sub-basin. Analyses indicate the Point Pleasant Formation has higher source rock potential and is less dense and more porous than the overlying Utica Shale. In addition, the interlayered carbonate and shale of the interval allows better fracture generation. Thus the presence of the Point Pleasant is key to the success of this play.

Because of the deposition of shales and limestones between the thicker carbonate platforms, the interval thickness of the Trenton/Lexington Limestone (figure 5) and that of the Utica-Point Pleasant interval (figure 9) are in a somewhat reciprocal relationship and define the sub-basin and the thick carbonate platforms that developed along much of the sub-basin margins. The thickness of the Utica-Point Pleasant interval ranges from approximately 100 ft in southern Ohio, where the Utica is absent, to over 350 ft in western Ohio, adjacent to the platform margin. Thickness of this interval in the northeast and north-central Ohio areas, where current activity is focused, is generally 200–250 ft. In southwestern Pennsylvania, the interval is thought to be composed primarily of Utica Shale and may reach as much as 700 ft thick, based on limited well data. The Trenton/Lexington Limestone grades laterally and upward to dominantly dark-gray to brown-to-black, platy, finely laminated, locally calcareous organic shale and interbedded limestone and calcareous shale of the Point Pleasant Formation. The Point Pleasant becomes more terrigenous and contains less organic carbon to the south as it comes up onto the Lexington Platform. The Utica is defined as dark gray-black, organic-rich shale with only sporadic calcareous-rich layers. The southern boundary is tenuous because of limited data.

The structure map on the top of the Trenton (base of Utica/Point Pleasant; Fig. 10) illustrates the present-day architecture of the northern Appalachian basin and, in western Ohio, Indiana and Ontario, the Cincinnati, Findlay, and Algonquin Arches. Regionally, the top of the Trenton ranges from +500 ft in Kentucky to as much as –14,000 ft in southwestern Pennsylvania. In Ohio the top of the Trenton ranges from –500 ft in western Ohio to –9,500 ft in extreme eastern Ohio.

Areas of historic conventional oil-and-gas production from the Trenton-Black River are found in northwestern and northeastern Ohio, Indiana, south-central New York, West Virginia, and Kentucky and are coincident with the platform margin in these states. These reservoirs and many others are thought to be sourced from the Utica/Point Pleasant interval (Cole and others, 1987). The Lima-Indiana Trend of northwestern Ohio and eastern Indiana alone produced over 350 million barrels of oil and 2 trillion cubic feet of gas (Wickstrom and others, 1992).

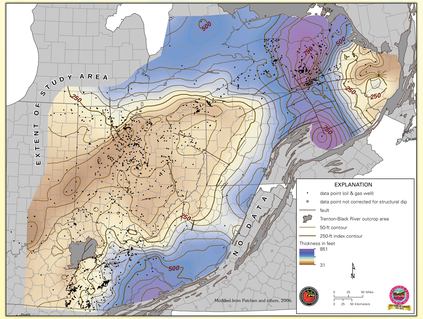


Figure 5.—Interval thickness of the Trenton/Lexington (top of Black River to top of the Trenton/Lexington Limestone).

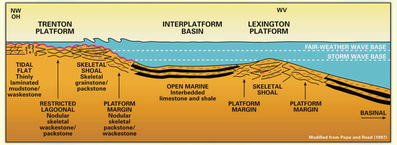


Figure 6.—Idealized platform-to-basin model and major facies.

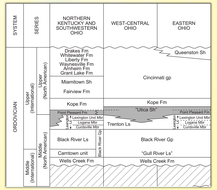


Figure 8.—Stratigraphic nomenclature for the Ordovician interval in Ohio and northern Kentucky.

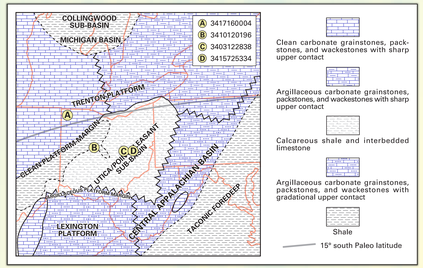


Figure 7.—Facies map of Trenton/Point Pleasant time (modified from Patchen and others, 1996). Paleoclimate is from Scotese and McKerrow (1990). Also shown are locations of selected wells in accompanying figures that illustrate facies changes across the basin.

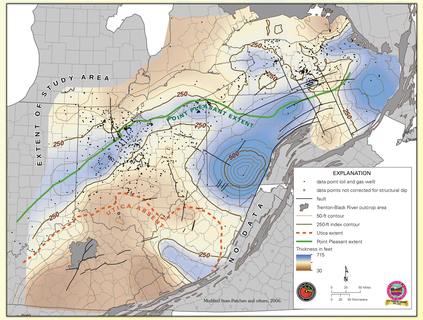


Figure 9.—Thickness map of the Utica-Point Pleasant interval (top of Trenton to top of Utica; includes the Point Pleasant and Antes Shale). The extent of the Utica and the Point Pleasant are also shown. The southern limit of the Utica is tenuous due to a limited amount of data.

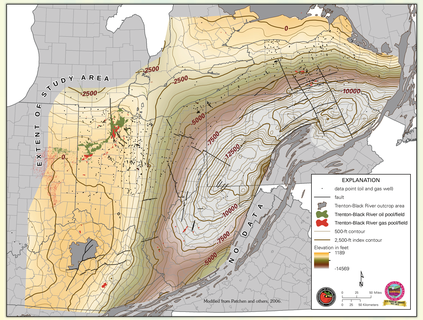


Figure 10.—Structure map on top of the Trenton Limestone.

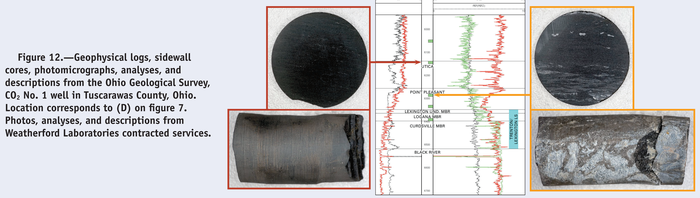
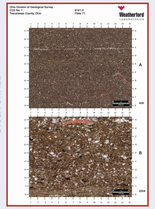
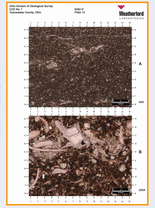


Figure 12.—Geophysical logs, sidewall cores, photomicrographs, analyses, and descriptions from the Ohio Geological Survey, CO_2 No. 1 well in Tuscarawas County, Ohio. Location corresponds to (D) on figure 7. Photos, analyses, and descriptions from Weatherford Laboratories contracted services.



Depth ..... 6141.0 ft
Permeability (Klink.)... 0.0002 mD
Porosity 5.1%
Grain Density ..... 2.70 gm/cc
Lithology ..... Slightly fossiliferous, silty mudstone (silty shale).
Framework Grains ..... Common fine to medium, silt-sized quartz and mica; scattered chambered calcareous fossil fragments.
Matrix ..... Abundant detrital clay.
Cements and Replacement Minerals.. Minor amount of calcite cement; scattered ferroan dolomite crystals replacing clay matrix; trace amount of microcrystalline pyrite replacement of shell material, organic material, and mud matrix.



Depth ..... 6282.0 ft
Permeability (Klink.)... 0.0003 mD
Porosity 4.2%
Grain Density ..... 2.70 gm/cc
Lithology ..... Fossiliferous, slightly dolomitic mudstone (shale) to argillaceous, skeletal wackestone.
Framework Grains ..... Minor fine, silt-sized to medium silt-sized quartz and mica; abundant calcareous fossil fragments (typically concentrated in layers), including bivalves, echinoderm fragments, ostracods, rare phosphatic shell fragments and brachiopod spines; common organic particles.
Matrix ..... Abundant detrital clay.

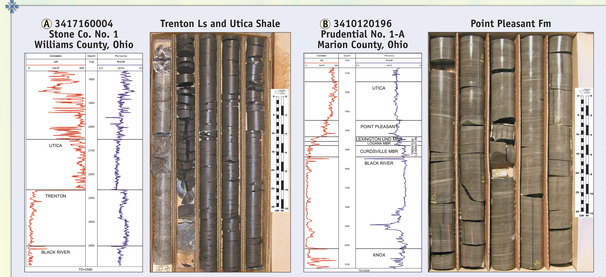
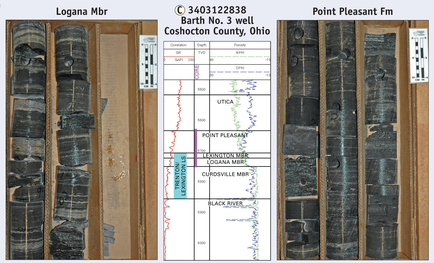



Figure 11.—Representative geophysical logs and core of the Trenton through Utica interval. Letters correspond to locations on figure 7. (A) The Point Pleasant is absent in northwestern Ohio, above the Trenton Platform. Here the Utica Shale is in a sharp contact with the Trenton Limestone. (B) Marion County core illustrates the very gradational sequence from the Trenton/Lexington strata through the Utica. Note the fine calcareous/limestone laminae of the Point Pleasant at this location. The top of the Point Pleasant is placed at the last occurrence of thin, interbedded limestone in the shale interval overlying the Trenton. (C) The Barth well has been the most heavily sampled core in the Ohio Geological Survey archives over the last few years. It contains a complete section from the Lexington through the base of the Utica. The Logana Member is a good marker bed and often contains some of the highest organic-carbon content. Note the crystalline facies within the organic-rich limestone of the Point Pleasant.