Source Rock Distribution and Total Organic Carbon Content
(excerpt with accompanying figures from Patchen and others, 2006)

Isopach maps of the Utica Shale, Point Pleasant Formation and Logana Shale Member of the Lexington Formation were prepared and furnished to the resource assessment team by the stratigraphy task team. However, because the Point Pleasant Formation, an eastern facies equivalent of the lower part of the Utica Shale, only occurs in a geographically restricted area in Ohio on what has been referred to as the eastern, or Lexington Platform, and in the narrow, inter-platform area to the west, these two units were mapped together. The resulting map indicated thickness ranging from 150–350 feet in Ohio, Ontario and New York, with thicker areas (600–1000 ft) in Pennsylvania and eastern New York

The Logana Shale Member of the Lexington Formation is present in the same general area as the Point Pleasant Formation in Ohio, and it ranges in thickness from 10–50 feet. This shale member also can be mapped farther to the south, where it attains a thickness of 130 feet in southern West Virginia.

The upper part of the Lexington Limestone consists of an unnamed limestone member, generally less than 100 feet thick throughout most of Ohio, overlying the Logana Shale Member and underlying the Point Pleasant Formation. This member thickens to the south, reaching 400 feet in eastern Kentucky and southern West Virginia where the younger Point Pleasant and Utica formations are not present. Because this limestone unit is relatively thin in Ohio where younger potential source beds are present, and thickens to the south where these younger shales are not present, it was decided to combine all these units—the Utica Shale, Point Pleasant Formation, upper limestone member of the Lexington Formation and Logana Shale Member of the Lexington Formation—in a single map.

The final isolith map (Figure 7-2) includes the thickness of all organic-rich beds, shale beds and interbedded limestones from the top of the Utica Shale to the bottom of the Logana Member of the Lexington Formation in Ohio; the Logana Member in eastern Kentucky and West Virginia where the Point Pleasant and Utica are not present; and the interval from the top to the bottom of the Utica Shale where only the Utica is present in Pennsylvania, Ontario and New York. Because the shales within the Point Pleasant Formation and Logana Member of the Lexington Formation are relatively thin, and because total organic carbon data were not available for the individual units, this mapping was deemed to be acceptable for our purposes.

Data for total organic carbon (TOC) were overlain on the isopach map of Ordovician shales with source rock potential and the data were contoured. For some data points (wells) both a minimum and maximum value were provided, whereas for other wells, only one value was provided. Therefore, three maps were generated: maximum TOC, average TOC, and minimum TOC, for the Utica Shale through Logana Member interval.

Adding these data defined areas of potential source rock within the larger area of shale distribution. The size of these areas varied greatly, depending on which map of TOC values was being observed. The map of maximum TOC (Figure 7-3) indicates that nearly the entire assessment area is in the good to very good range. Exceptions are thin, linear, northeast–southwest trends of fair to poor TOC values along the Ohio River between West Virginia and Ohio and smaller, parallel trends farther west in Ohio; and two northwest–southeast trends in New York, extending from Lake Ontario toward the areas of known gas production.

The map of minimum TOC values (Figure 7-4) presents a more pessimistic picture. Small areas in Ohio, Pennsylvania and New York are deemed to be very good and occur within a much larger area of these same three states that is in the good range for TOC. However, southern Ohio and most of West Virginia is mapped as having mostly poor potential.

The TOC map that displays the most likely scenario is the map of average TOC values for the Utica through Logana interval (Figure 7-5). On this map, most of the assessment area falls within the good to very good range. Exceptions are a large area south of Lake Erie and Lake Ontario, and the parallel, southwest–northeast trends along the Ohio River and southern Ohio noted on the map of maximum TOC. A comparison of this map of average TOC with the isopach map of potential shale source beds reveals a close correlation between shale thickness and TOC. Areas of thinner shale have lower TOC values for the shale that is present, whereas areas of thicker shales have higher TOC values in those shales.

At this point, the team was prepared to superimpose maps of productive areas and potential reservoir rock on the source rock map to determine viable areas from which the gas may have been directly sourced, and areas to the west, where gas must have migrated from source beds farther to the east.

However, other data developed during the project suggest that a deeper source rock or rocks may have generated some of the gas found in Trenton and Black River reservoirs, especially in some of the New York fields (see Geochemistry Chapter). Some of these deeper beds may be shale facies in the eastern portion of the Rome Trough. Therefore, it was determined that it would be necessary to add the area of the Rome Trough to the source rock map, as an area of maximum distribution of a deeper source rock or rocks. TOC data for deeper Cambrian rocks, such as the Rome Formation, have indicated at least a limited source rock potential in these deeper beds (see Ryder et al, 2003). TOC data from 28 deep wells in the basin indicate that in 11 of the 28 wells, TOC values were greater than 0.5% in the Beekmantown Formation and deeper formations. The highest values are 4.4% from the Rogersville Shale in a Wayne County, West Virginia deep well; 3.26% from the Rome Formation in Kentucky, 2.83% and 1.12% from the Conasauga Formation in West Virginia, and 1.17% from the Beekmantown Formation in Pennsylvania. Other TOC values range from 0.57% to 0.88% (unpublished data from the Rome Trough Consortium and the Pennsylvania Geological Survey).

Thermal Maturity (CAI)

The final maps of CAI data, in conjunction with profiles of thermal maturity along cross section lines based on deep wells, were used to draw boundary lines between areas of oil generation; gas generation; overmaturation; and immature source rocks (Figure 7-8). Oil fields to the west, in the area of immature source beds, must have been charged by oil that migrated up dip from an oil-generating area. Likewise, gas fields to the west, in areas that fall into the oil window and immature areas, must have been charged by gas migrating up dip from gas-generating areas farther to the east.

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Ryder, R.T., Harris, D.C., Gerome, Paul, Hainsworth, T.J., Burruss, R.C., Lillis, P.G., and Jarvie, D.M., 2003, Cambrian petroleum source rocks in the Rome trough of West Virginia and Kentucky [abs.], *in* Eastern Section AAPG Annual Meeting Program with Abstracts: American Association of Petroleum Geologists Eastern Section, Pittsburgh, September 6–10, 2003, p. 29.

Editor's Note

See the accompanying Microsoft Excel document *Utica_SourceRock_Analysis_Data.xls* for source rock and well header data for wells in these formations in Ohio.

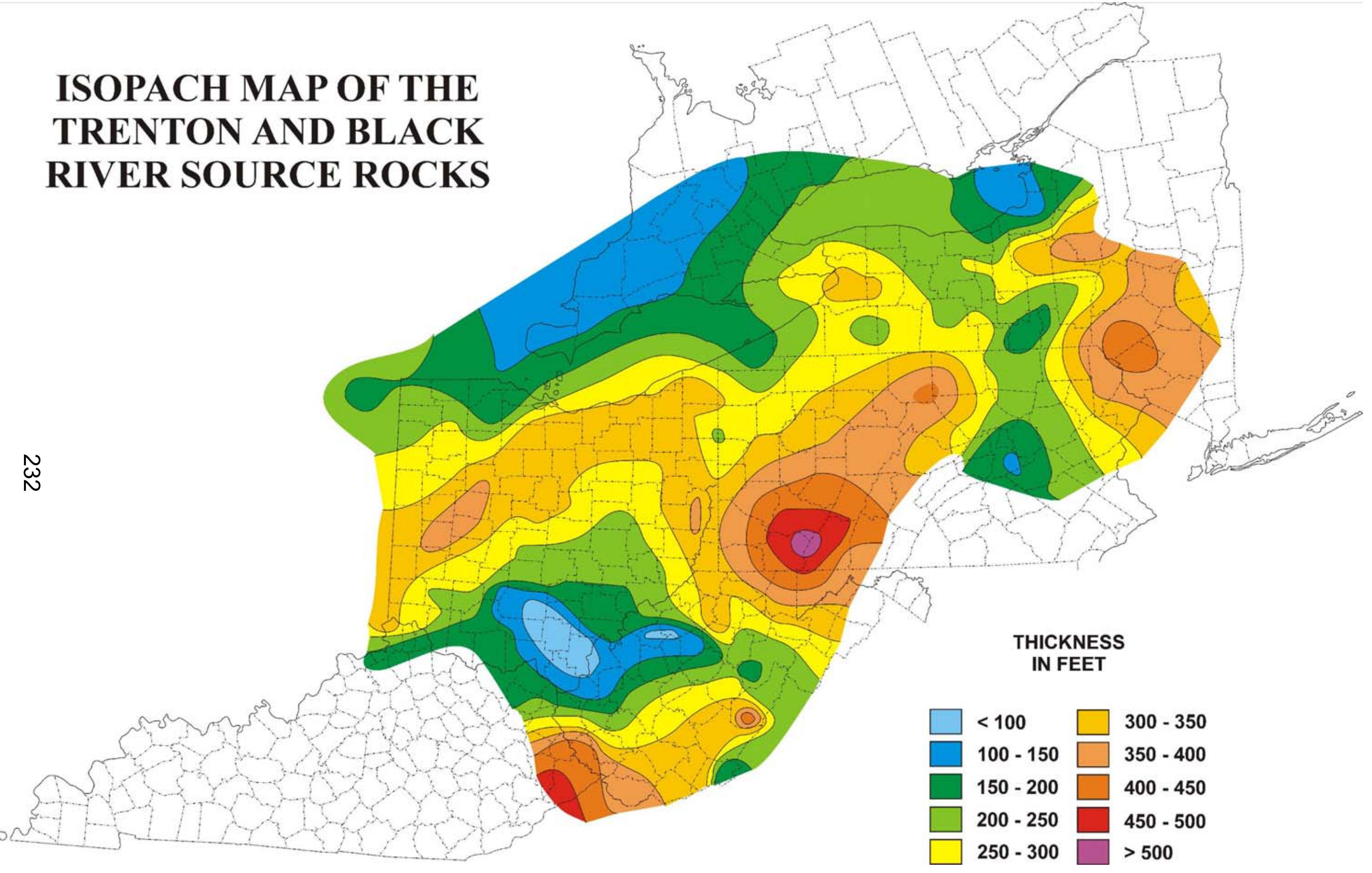

ISOPACH MAP OF THE TRENTON AND BLACK RIVER SOURCE ROCKS
THICKNESS IN FEET
< 100
100 - 150
150 - 200
200 - 250
250 - 300
300 - 350
350 - 400
400 - 450
450 - 500
> 500

Figure 7-2

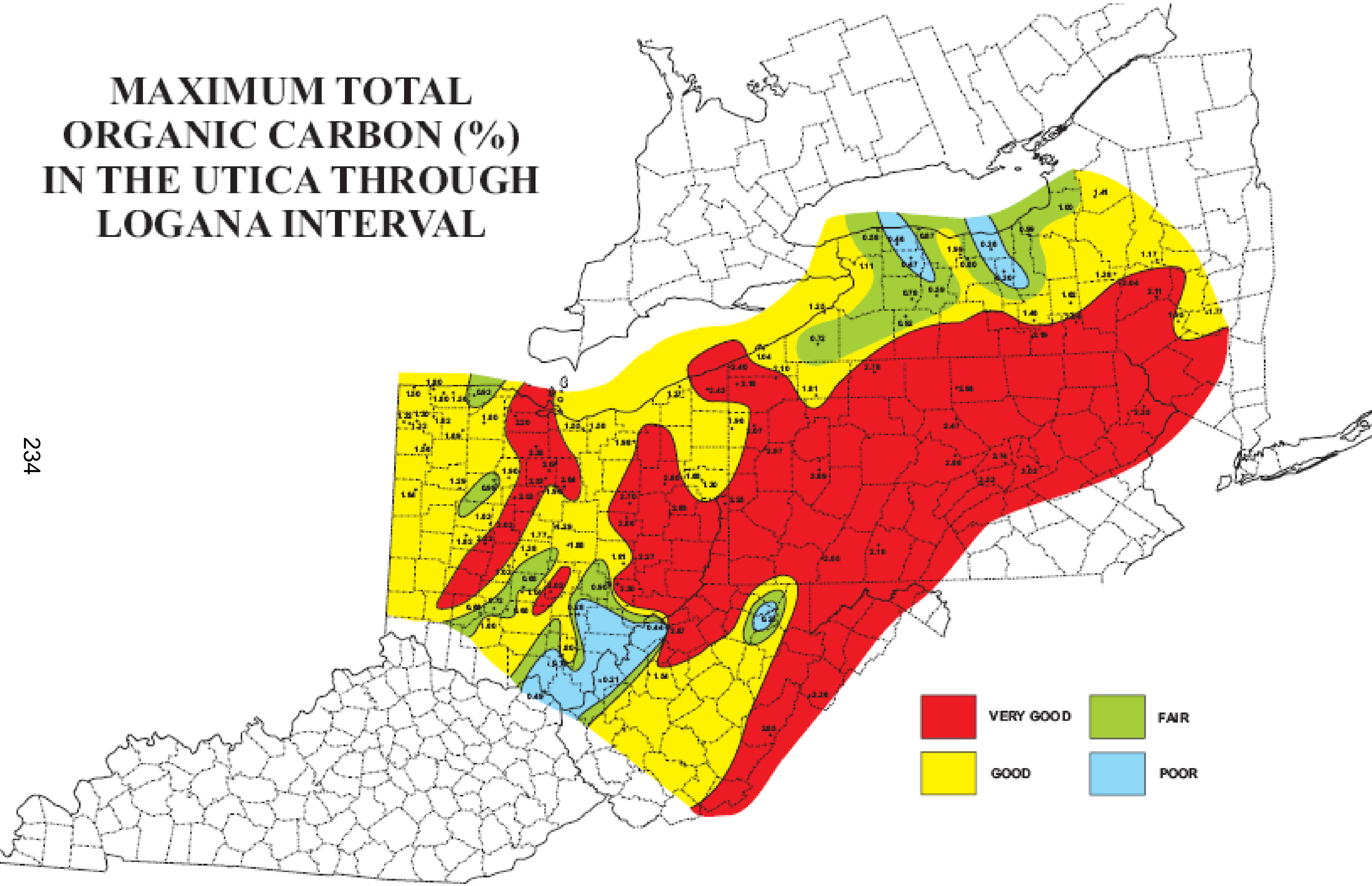

MAXIMUM TOTAL
ORGANIC CARBON (%)
IN THE UTICA THROUGH
LOGANA INTERVAL
VERY GOOD
FAIR
GOOD
POOR

Figure 7-3.

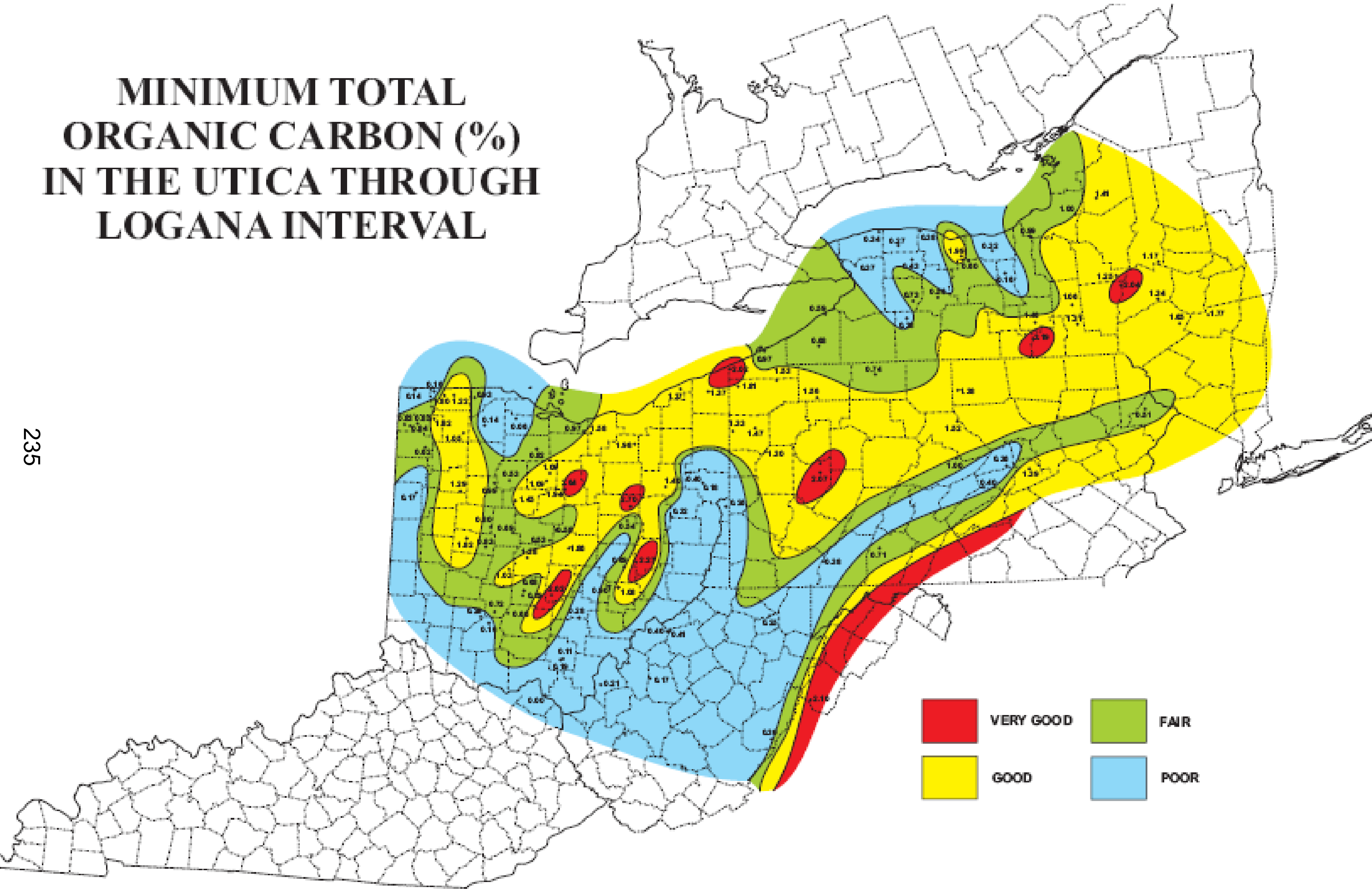

MINIMUM TOTAL ORGANIC CARBON (%) IN THE UTICA THROUGH LOGANA INTERVAL
VERY GOOD
FAIR
GOOD
POOR

Figure 7-4.

AVERAGE TOTAL ORGANIC CARBON (%) IN THE UTICA THROUGH LOGANA INTERVAL

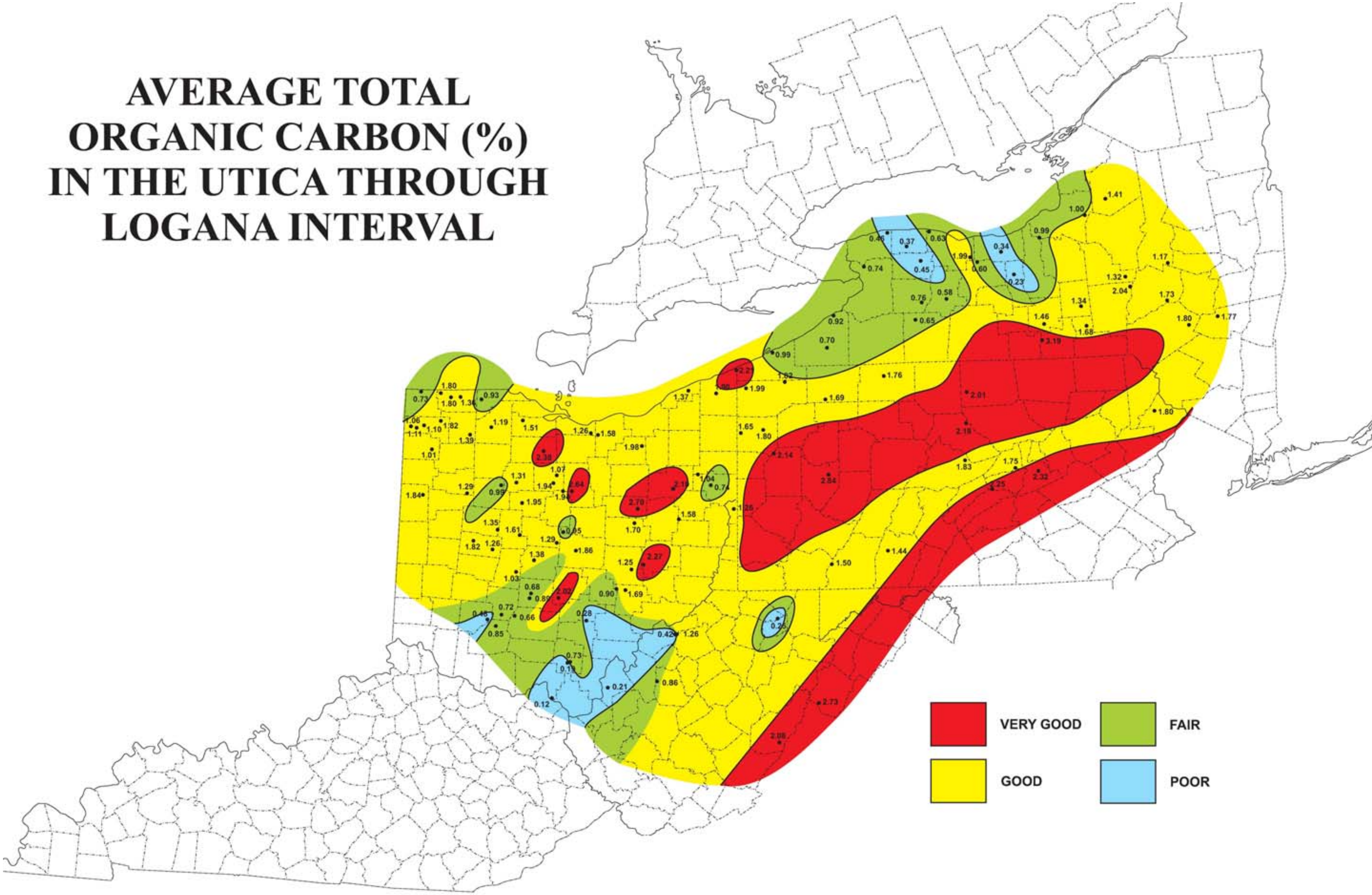
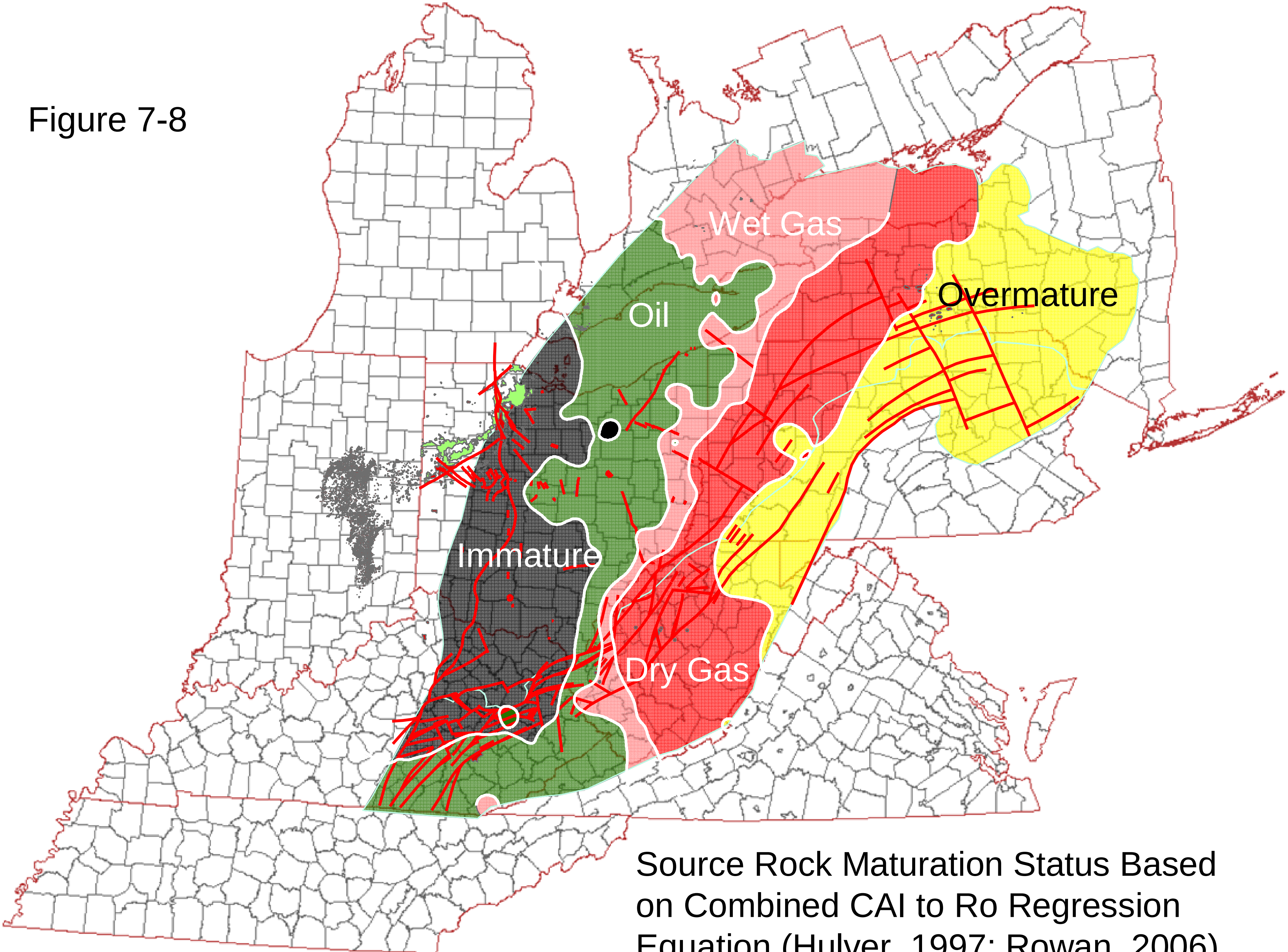


Figure 7-5.

Figure 7-8



Source Rock Maturation Status Based on Combined CAI to Ro Regression Equation (Hulver, 1997; Rowan, 2006)