

USGS Assessment of In-Place, Oil-Shale Resources of the Upper Devonian Antrim Shale in the Michigan Basin, Eastern United States

Alex W. Karlsen¹, Tracey J. Mercier², Frank T. Dulong¹, Sandra G. Neuzil¹, Ronald C. Johnson²

¹ U.S. Geological Survey, National Center M.S. 956, 12201 Sunrise Valley Dr., Reston, VA 20192, akarlsen@usgs.gov

² U.S. Geological Survey, Box 25046, Denver Federal Center M.S. 939, Denver, CO 80225

The U.S. Geological Survey is assessing in-place, oil-shale resources in the immature Upper Devonian Antrim Shale in the Michigan Basin. The Antrim Shale is a black, organic-rich shale that was deposited during the Late Devonian Period in a large epeiric, low-energy, marine environment that covered Michigan, northern Indiana, northwestern Ohio, and parts of Lake Michigan and Lake Huron; it was also part of the Devonian sea that covered a large area of the eastern United States. In the western part of the Michigan Basin, the Antrim Shale grades into the contemporaneous Ellsworth Shale, a low-organic content, gray shale. The depth of the Antrim Shale varies from surface (outcrop at the basin margins) to approximately 2,500 feet in the basin center. Within the north-central part of the Michigan Basin, the Antrim Shale is greater than 750 feet thick. Only a small area in the north-central part of the basin reaches thermal maturity in the oil window (greater than 0.6% Ro).

An earlier assessment of 2.82 trillion barrels of in-place, oil-shale resources of the Michigan Basin by Leffert and Schroeder (1980) was based on average values for thickness, Fischer assay oil yield, and shale density for the Antrim Shale. In this USGS assessment, the assessment unit for the Michigan Basin is defined by the aerial extent of the Antrim Shale that is greater than 10 feet thick, less than 6,000 feet below the surface, and does not lie under the Great Lakes. Leffert and Schroeder (1980) provide 841 Fischer assay oil yield records, and Hockings (1980) provides shale density data for approximately 350 samples from Antrim Shale cuttings and core from 30 locations in the Michigan Basin. These data are used to calculate the thickness-weighted average oil yield in gallons per ton (GPT) at each location. Shale density at each location is based on the Fischer assay oil yield and shale density relation for all samples. The in-place, oil-shale resource calculation uses a Voronoi (polygons) method to interpolate and extrapolate thickness, oil yield, and shale density between data locations. Because current in-situ retort methods are believed to impact large volumes of rock irrespective of richness grade, thin shale zones in the middle of the Antrim Shale with lower oil yields between zones with higher oil yields near the base and top of the Antrim Shale will be included in resource estimates. Preliminary calculations indicate a smaller in-place, oil-shale estimate than the 1980 assessment.