

Four Distinct Woodford Shale Plays in Oklahoma: Gas, Condensate, Oil, and Biogenic Methane.

Brian J. Cardott

Oklahoma Geological Survey, Norman, Oklahoma

In addition to producing thermogenic methane, four distinct Woodford Shale (Late Devonian-Early Mississippian) hydrocarbon plays in Oklahoma may be divided by the distinguishing secondary type of hydrocarbon produced: Arkoma Basin (thermogenic methane); Anadarko Basin (condensate); Ardmore Basin (oil); Cherokee Platform (biogenic methane). A gas shale completions database contains records of 327 vertical and 1,119 horizontal Woodford Shale-only (non-commingled) wells drilled since 2004. In Oklahoma, gas production is reported by well while oil production is reported by lease.

Arkoma Basin: The thermogenic methane Woodford Shale play in the eastern Oklahoma Arkoma Basin (primarily in Atoka, Coal, Hughes, McIntosh, Okfuskee, and Pittsburg counties) occurs at a thermal maturity of @0.8 to 4% vitrinite reflectance (VRo). Total vertical depths of 1,007 Woodford Shale wells in the Arkoma Basin range from 691 to 13,810 ft, while initial potential gas rates range from 3 to 12,097 thousand cubic feet per day (Mcf/d). Horizontal well lateral lengths in the Woodford Shale range from 52 to 10,195 ft. The Arkoma Basin is known as a dry-gas geologic province with Woodford Shale thermal maturities primarily in the dry-gas window (1.4 to >6% VRo). Even though most of the wells produce primarily thermogenic methane, condensate is produced in high thermal maturity wells up to @1.9% VRo. The thermal maturity of these condensate-producing wells is higher than known for any other gas-shale play. Analysis of producing-well rock and condensate samples by the time of the meeting will verify the thermal maturity and source of the produced liquid hydrocarbons. Low liquid hydrocarbon production (<562 barrels per month) in the first six months or less, in some wells at thermal maturities up to @2.4% VRo, is thought to be flowback from diesel oil-based drilling mud (API oil gravity is not available to verify source).

Anadarko Basin: A condensate Woodford Shale play in the western Oklahoma Anadarko Basin occurs at a thermal maturity of 1.2 to 1.4% VRo. The thermal maturity of the wells in the play ranges from @1.1 to >1.5% VRo. Total vertical depths of 87 Woodford Shale wells in the Cana play (in parts of Blaine, Caddo, Canadian, and Grady counties) range from 11,075 to 14,654 ft. All wells except one are horizontal wells with lateral lengths of 2,230 to 6,536 ft. Initial potential gas rates from the horizontal wells range from 668 to 8,367 Mcf/d. Initial potential oil/condensate rates range from 2 to 310 barrels of oil per day (Bopd). Reported oil/condensate gravities range from 45 to 65 API degrees.

Ardmore Basin: Vertical and horizontal Woodford Shale oil wells (based on a gas to oil ratio of <10,000:1) and gas wells with oil/condensate production occur in the southern Oklahoma Ardmore Basin (Carter, Johnston, and Marshall counties) at a thermal maturity of <1.2% VRo. Total vertical depths of 98 Woodford Shale wells range from 1,750 to 12,200 ft. Initial potential gas rates range from 10 to 3,307 Mcf/d. Initial potential oil rates range from 1 to 371 Bopd. Based on wells where the operator provided data in the completion report, oil gravity ranges by county are as follows: Carter County, 28 to 54 API degrees; Johnston County, 37 to 51 API degrees; Marshall County, 31 to 40 API degrees. A boundary of 49 API degrees is used to distinguish oil and condensate.

Cherokee Platform: Some of the 182 shallow (depths of 422 to 2,204 ft) vertical Woodford Shale wells in the northeast Oklahoma Cherokee Platform (primarily in Wagoner County) include production of biogenic methane. Access to groundwater and microbes near the surface comes from outcrops in the Ozark Uplift to the northeast. Initial potential gas rates range from 1 to 526 Mcfd. Oil production reported from two Woodford Shale wells was from a Pennsylvanian-age Dutcher sand well on the same lease.

Woodford Shale Completions (2004-2010)

