

**HISTORY AND GEOLOGY OF THE GIANT  
BRADFORD OIL FIELD,  
MCKEAN COUNTY, PA AND CATTARAUGUS  
COUNTY, NY**

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**KEYNOTE ADDRESS**

Bradford oil field encompasses about 85,000 acres in north-central McKean County, PA, and south-central Cattaraugus County, NY. The first well in the area was drilled in 1861 – the first producing well in 1864 – but the field didn't establish true commercial production until 1871. By mid-1884, it was the most prolific producer on the globe, having topped the 100 million barrel mark, which established it as the world's first giant oil field. Bradford field has since gone on to produce more than 681 million barrels of crude oil.

The primary reservoir in Bradford field is the Bradford Third sand within the Upper Devonian Bradford Group. It was probably the most intensively studied oil reservoir in the world during the early and mid-20<sup>th</sup> Century. The reservoir rock, averaging 38 feet in thickness, consists primarily of medium- to fine-grained greywackes with subordinate interbedded siltstone and shale layers. Gentle folds enhanced production early on by enhancing porosity and permeability and reducing water saturation close to the axes. Bradford Third

porosity ranges from less than one to 26 percent throughout the sandstone, but in the pay interval it varies from 1.4 to 19 percent and averages 14.5 percent. Permeability ranges from <0.1 to >350 mD. Water saturation before the introduction of water flooding generally was less than 10 percent.

Bradford field was subjected to water flooding throughout the 20<sup>th</sup> Century. Unintentional water flooding began very early, and intentional flooding began around 1890, but the impact on production wasn't noticeable until 1907. Extensive water flooding, initiated in 1928 when the 5-spot method was introduced, resulted in production of 416 million barrels of oil through the 1990s when drilling and production in the field went into general decline. The Bradford Third sand is now considered to be watered out. Bradford field also has been the site of various tertiary recovery field tests, including both chemical and thermal methods, but all have so far ended with disappointing or, at best, only mixed results.

In the 1940s, the Pennsylvania Geological Survey estimated that the original oil in place (OOIP) in Bradford field was 1,075 million barrels. It is often estimated that primary and secondary recovery methods will ultimately produce about 30 percent of the OOIP. Yet, by the 1940s, the field already had produced about 36 percent of the estimated OOIP. To date, the field has produced about 63 percent of that 1,075 million barrels, so the OOIP needs to be recalculated. If the 30 percent recovery figure is correct, based on the total production to date, the OOIP would amount to 2,270 million barrels of oil, of which 1,589 million barrels remain in the reservoir. Improved technology and higher prices can help take a big chunk out of that remaining oil. Bradford field's reservoir characteristics make Bradford oil field an ideal location for more modern tertiary recovery operations, such as CO<sub>2</sub> flooding, which could result in substantial additional oil recovery.