



The “Clinton” Oil-And-Gas Play in Ohio

Since the first reported production of coal in 1800, Ohio has been a major player in the United States energy industry. Sixty years after the first reported production of coal, Ohioans began producing oil and natural gas in 1860. At scale, oil and gas can be produced efficiently from groups of wells known as *fields*. Groups of oil fields that produce from the same geologic unit are known as *plays*. Since it first began producing oil and gas in 1887, the “Clinton” oil-and-gas play has been the most actively drilled energy-bearing geologic formation in Ohio (fig. 1). The “Clinton” sandstone (also known as the “Clinton” or “Clinton sand”) is a geologic formation in the subsurface of eastern Ohio consisting of interbedded sandstones and shales. The usage of quotes in the name of the “Clinton” sandstone indicates an informal name and that the “Clinton” sandstone is not related to the younger Clinton Formation in Ohio. The first “Clinton” well was drilled by citizens of Lancaster, a city about 30 miles southeast of Columbus, who aspired to replicate the 1884 discovery of natural gas in the older Trenton Limestone at the city of Findlay in western Ohio. Over the years, the “Clinton” has seen a variety of development methods and technologies which have helped to make it the most enduring and prolific oil-and-gas play in Ohio.

History of production

The successful production of natural gas from the Trenton Limestone at Findlay in 1884 motivated citizens, landowners, and oil speculators to seek additional areas of the state where oil-and-gas resources could be produced. Citizens of Lancaster were the first to organize drilling of an exploratory well which produced natural gas from the “Clinton.” Drilling began in 1886 and production followed in 1887. However, large discoveries of gas in the “Clinton” did not occur at Lancaster until 1889, when two high-volume wells were drilled.

The initial discoveries in the late 1800s sparked the drilling of tens of thousands of wells into hundreds of oil-and-gas fields throughout the eastern half of Ohio. Some of these oil-and-gas fields are still being developed today, not only as a source of hydrocarbons, but also for gas storage, waste disposal, and enhanced oil recovery.

Throughout the history of “Clinton” production, the drilling technologies applied to oil-and-gas extraction have come a long way. Prior to the 1950s, the cable tool method was the most common method of drilling oil-and-gas wells in Ohio. This method involves a large metal chisel attached to a drill pipe continuously dropped and pulled back up a few feet into the drill hole. The large chisel fractures the rocks until the rock chips are washed out using a bailer. The development of the “Clinton” changed with the introduction of rotary drilling in Ohio in the early 1950s (fig. 2). Rotary drilling uses a large drill bit attached to the end of a heavy drill pipe. The weight of the drill pipe forces the drill bit into the formation while a motor at the surface rotates the drill pipe and the drill bit.

As the bit rotates, it crushes the rocks into sand-sized particles, and drilling mud flushes particles out of the drill hole. This method made drilling more efficient and even safer. In the early days of oil-and-gas production, wells were “shot” with nitroglycerine to increase production. Although this method of well stimulation was generally successful,

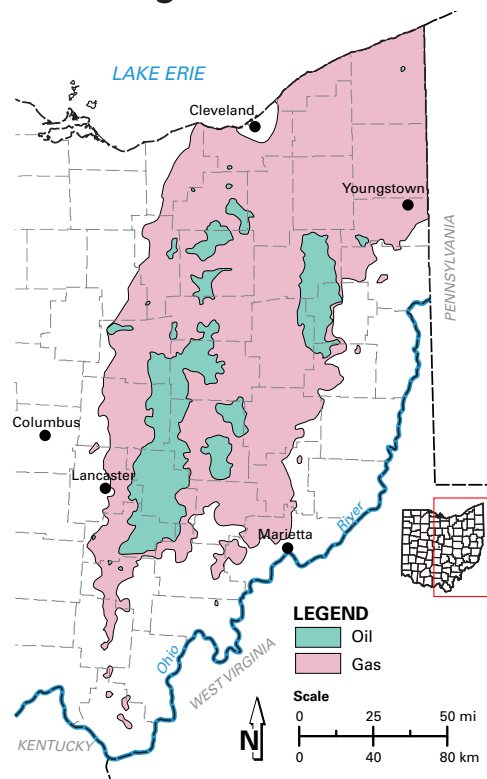


Figure 1. Map showing the locations of the “Clinton” oil-and-gas fields in Ohio (modified from Riley and others, 2004).

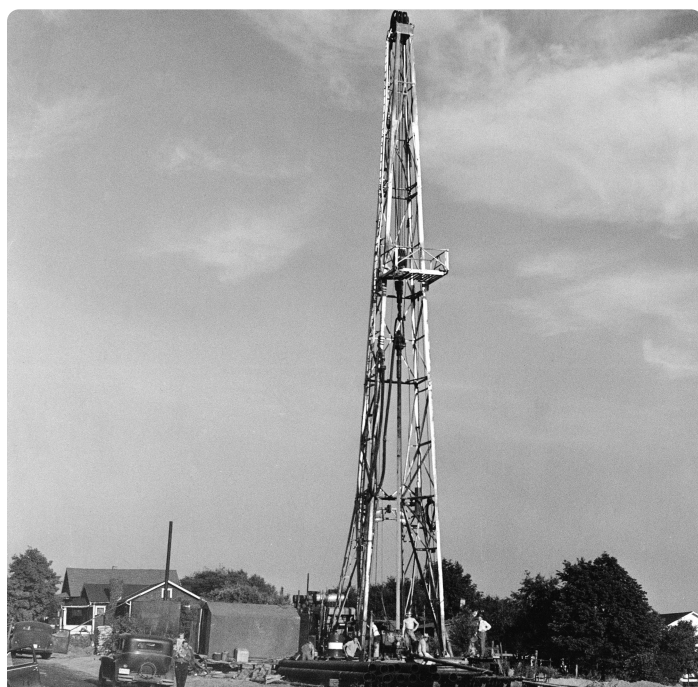


Figure 2. Historical photo of a rotary drill rig in Canton, Ohio, drilling into the “Clinton” sandstone.

the numerous accounts of massive accidental explosions encouraged the development of new technologies.

Beginning in 1949, a new method of well stimulation was introduced that is still used throughout Ohio today. Hydraulic fracturing, known as “fracking,” stimulates wells by pumping drilling fluids into a borehole with enough pressure to create fractures in the producing rocks. Tight formations such as the “Clinton” have insufficient permeability to allow oil and gas to flow freely into the borehole and to the surface. These formations require additional stimulation treatments to make the well commercially profitable.

Geology

Abundant oil-and-gas deposits in the “Clinton” sandstone are the result of the underlying geology. The “Clinton” is known as a fluvial-deltaic deposit, similar to deposits being created by the modern-day Mississippi River delta in the southern United States. Deposition of the “Clinton” occurred nearly 444 million years ago (fig. 3). At that time, the early Appalachian Mountains bordered the eastern margin of the North American continent. Rivers transported sediments eroded from the mountains westward to coastal deltas and sandy shorelines that formed in eastern Ohio. As time passed, more sediment inflow caused the sandy shoreline to extend westward towards the shallow sea.

After deposition of the eroded sediments from the mountains, thousands of feet of additional sediment buried the “Clinton” sands for the next few hundred million years. Eventually, the sediments deposited during the Silurian Period (443.8–419.2 million years ago) were lithified into the solid rocks we now know as the “Clinton” sandstone. Meanwhile, under the “Clinton” sandstone, the organic-rich Point Pleasant Formation had been generating oil and gas. The Point Pleasant Formation is an interbedded limestone and shale unit that is organic rich. The organic material present in the Point Pleasant Formation is a direct result of algae and other microscopic plants and animals dying, drifting downward, and becoming buried within the setting of a deep basin. Eventually, the organic matter undergoes heating and begins to break down into oil and natural gas. Oil and gas are less dense than saline water, which typically fills the pores and fractures of formations in the subsurface. As a result of this difference in density, oil and gas flow upward, much like cooking oil in a soup. Oil and gas continue to migrate upward until they either reach the surface or get trapped in a reservoir. The sandstones within the “Clinton” are porous enough to trap oil and gas from the deeper Point Pleasant Formation.

Within Ohio, the “Clinton” is present between 2,000 and 6,500 feet below the surface in the eastern half of the state (fig. 1). The sandstones of the “Clinton” reach these depths in eastern Ohio because of *subsidence* (the sinking of the ground) of the Appalachian Basin, a depression in Earth’s crust that formed in response to mountain-building events to the east. The depth of the “Clinton” below the surface means that it cannot be studied by traditional methods; instead, geologists look at information gathered during drilling to learn more about the “Clinton.”

The most abundant subsurface data available for the “Clinton” come from over 100,000 wells drilled over the years. Well data include the depths at which the “Clinton” was encountered while drilling from the surface. Drillers record the depths at which they penetrate the tops of distinctive

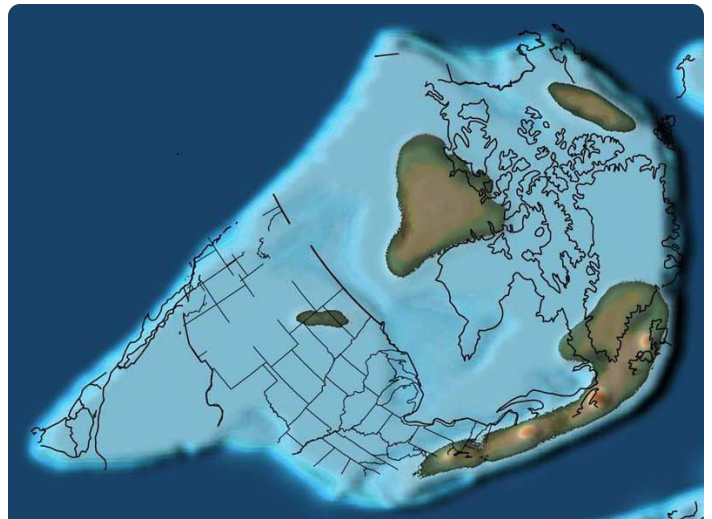


Figure 3. Paleogeographic map of the Early Silurian Period, about 440 million years ago (modified from Scotese, 2014).

formations. Data from these so-called “picks” have gotten better with technological advances and as modern geophysical logs have advanced the accuracy of subsurface data.

In addition to oil-and-gas production, the “Clinton” reservoirs are used for several other purposes. One such use is natural gas storage. Depleted reservoirs have natural gas pumped into them by gas companies. In winter, when residents have a high demand for gas to heat their homes and businesses, these “Clinton” gas storage fields can supply added gas without interruption. Depleted reservoirs in the “Clinton” also are used to dispose of wastewater from oil-and-gas production. Not only are production wastes disposed of in the “Clinton,” but captured CO₂ may be sequestered in depleted reservoirs as well. The placement of these fluids in depleted reservoirs keeps them out of groundwater supplies and the atmosphere. In addition, the injection of water and/or CO₂ can help operators recover more of the hydrocarbon reserves from nearby “Clinton” wells using enhanced oil-recovery methods. Ongoing research by government agencies, universities, and private industry will continue to help us to better understand the geology and resource potential of the “Clinton” sandstone and surrounding rock units.

References & Further Reading

- Riley, R.A., Baranoski, M.T., Wickstrom, L.H., 2004, Oil and gas fields of Ohio: Ohio Department of Natural Resources, Division of Geological Survey Map PG-1, scale 1:500,000.
- Scotese, C.R., 2014, Atlas of Silurian and Middle-Late Ordovician paleogeographic maps (Mollweide projection), Map 76 in Volume 5, The Early Paleozoic: Evanston, Ill., PALEOMAP Atlas for ArcGIS, PALEOMAP Project, last accessed December 4, 2023 at <https://www.earthbyte.org/webdav/ftp/Data_Collections/Scotese_Wright_2018_PaleoDEM/PALEOMAP_PaleoAtlases.zip>.