GEOLOGY AND OCCURRENCE OF OIL AND GAS IN CHAUTAUQUA COUNTY, NEW YORK

Arthur M. Van Tyne, Senior Geologist-in-Charge, Oil and Gas Office, Geological Survey, New York State Museum and Science Service, Alfred, New York

HISTORY-SHALE GAS DRILLING

The first natural gas well completed in New York State, and the United States, was drilled at Fredonia in 1821 to a depth of 70 feet. The owner and driller of the well, William A. Hart, was the first man to market natural gas in the United States and, through his efforts, Fredonia became the first community in the United States to be lighted by natural gas. During his visit to the village in June of 1825 General Lafayette is said to have been delighted by the gas light illumination. The well produced gas in declining volume for a number of years but no enlargement of service was possible. Therefore, in order to secure a new supply of gas, Mr. Preston Barmore drilled a new gas well during the year 1858. The well was located about one mile northwest of the Hart well and consisted of a dug cavity about 30 feet deep in the bottom of which two holes were drilled to depths of 100 and 150 feet. In the fall of 1858 Mr. Barmore, together with Elias Forbes, formed the Fredonia Gas Light Company and commenced supplying gas to the village. The first deep well was drilled by Alvah Colburn in 1871 at his mill located south of Main Street. The well which was drilled to a depth of 1,256 feet encountered gas between 130 to 300 feet, and reached the Onondaga limestone at 1,079 feet. A concerted effort to find more gas was initiated and it is estimated that 300 shale gas wells were drilled in Chautauqua County towards that end.

Medina Drilling

During the autumn of 1886, and the first half of 1887, the first Medina Sandstone well in the county was drilled about one-half mile southeast of the village by the Fredonia Gas and Fuel Company. This well reached a total depth of a little over 2,500 feet and obtained production of about 7,000 cubic feet of gas per day, with a maximum pressure of 160 pounds, from the Medina. Additional Medina drilling did not take place until 1903 when the South Shore Gas Company and the Brocton Gas Company began to drill Medina wells in the Brocton and Silver Springs areas. This development was probably spurred by successful Medina drilling to the north in Erie County around the turn of the century. Since 1903, drilling in Chautauqua County has continued on a sporadic basis with the majority of wells being drilled for Medina sandstone gas production. It appears that the present spurt in Medina drilling, commenced in 1973, will surpass all previous periods of drilling in the total number of wells drilled. It is estimated that about 700 Medina wells have been drilled to date in Chautauqua County.

Deep Drilling

The first of ten deep wells drilled in Chautauqua County was the Cassity #1 of Frost Gas located one-half mile east of Dunkirk. This well was originally drilled to a depth of 2,052 feet in 1908 and was re-entered and drilled deeper in 1916. The well topped the Trenton at 4,010 feet and was stoped at 4,035 feet. The Niehaus well, located two and one-half miles northeast of Dunkirk, was also an old well which was drilled deeper to 4,517 feet. The drilling was stopped in 1949 after encountering a good show of gas and considerable salt water in the Cambrian Theresa (Galway) Sandstone.

Since then, eight more deep wells have been completed all ending in Cambrian sandstones except one which stopped in the Trenton. No well has been drilled to basement rocks in Chautauqua County, but the deepest well in the county, the Harrington #1 of Wolf's Head Oil located six miles northwest of Jamestown and one-quarter mile east of Ellery was completed at 7,694 feet in the Cambrian Potsdam Sandstone which overlies basement rocks. Two of the deep wells had good shows of gas from Cambrian sandstones, but no commercial gas or oil production has so far been found in the Cambro-Ordovician rocks of Chautauqua County.

OIL EXPLORATION

During the drilling of the early shale gas wells, a small amount of oil was often recovered along with the gas. However, the first intensive drilling program to find oil in Chautauqua County did not take place until 1919 when the Poland Oil and Gas Company began to drill in Poland Township, about eight miles east of Jamestown. Three shallow wells were drilled on Mud Creek and some gas, but no oil, was found.

Subsequently, 19 wells up to 800 feet deep were drilled about one and one-half miles south of Clark. Although some oil was found only a small amount was ever produced and the wells were abandoned. Other operators drilled several wells three and one-half miles southwest of the Poland Township drilling, about two miles north of Frewsburg in Carroll Township. These wells produced a small amount of oil but were eventually abandoned.

In September, 1924 the Republic Light, Heat and Power Company, while drilling for gas on the Jacob Yonkers farm three and one-half miles northeast of Fredonia in Sheridan Township, encountered a flow of 100 barrels of oil per day together with a total flow of 2,400 Mcf (thousand cubic feet) of gas per day from the Onondaga limestone ("Flint" of the drillers). The Onondaga was topped at 1,315 feet and the oil flow occurred at 1,485 feet. One other well drilled nearby encountered some oil in this same zone but oil production from both wells declined rapidly and apparently only a few thousand barrels of oil were produced. One year later, in September, 1925, oil was found in this same zone in a well drilled

on the Muscato farm located two miles east of Fredonia and two miles southwest of the Yonkers well. Several wells were eventually drilled on this farm, but total oil production is said to have been less than 10,000 barrels.

In 1945 Todd M. Pettigrew, backed by the Thomas brothers of Chicago, began a drilling program to develop oil production in the Busti area located about four miles southwest of Jamestown. Several wells were drilled over a three year period and a modest production was established from the Glade sand at about 700 feet in depth. However, the sand is tight and initial production declined rapidly making the operation uneconomic. By late 1948 the properties were abandoned or farmed-out to other interests who later abandoned them. An interesting aspect of the Pettigrew operation was the use of a "secret" electronic device to aid in locating oil bearing rocks.

The Pettigrew operation was somewhat premature in attempting to develop economic production in tight sandstones such as the Glade. It was not until the mid-1950's development of the hydraulic fracturing technique of well stimulation and its subsequent introduction into the Appalachian area that the oil in such rocks could be successfully produced. In New York the first wells were "fraced" in the late 1950's and early 1960's. The highly successful results of these early treatments caused a rapid increase in the useage of hydraulic fracturing so that by the late 1960's and early 1970's this procedure had almost completely supplanted shooting with nitroglycerin as a well stimulation method. Through the use of this technique the Busti area development has been revived. Starting in 1962, and still proceeding, some 315 oil wells have been drilled in the Busti Field. Total oil production from Busti, partly from actual production figures and partly estimated, is 775,000 barrels with estimated primary reserves of 500,000 barrels. It is estimated that 375 oil, or oil exploratory, wells have been drilled in Chautauqua County.

STRATIGRAPHY OF OIL AND GAS PRODUCING ROCKS

A generalized stratigraphic section of the rocks present on the surface and in the subsurface of Chautauqua County is shown in Fig. 1. About 2,100 feet of section, from the Knapp conglomerate of Mississippian age at the top to the Upper Devonian West Falls Group at the base, is exposed in outcrop. Beneath this there is an additional thickness of about 7,500 feet of sedimentary section above Pre-Cambrian rocks. The early shale gas wells were drilled in rocks of the Canadaway Group as are the oil wells in the eastern part of the county. The top of the major gas producing zone in the county, the Lower Silurian Medina Sandstone, is found at shallowest depths of 1,650 to 1,700 feet at a surface elevation of 600 feet in Hanover Township in the northeastern corner of the county. The deepest Medina penetration was registered in the Weiss #1 dry hole located in the Kiantone area about five miles southeast of Jamestown. Here the Medina top was found at 4,194 feet at a surface elevation of 1,244 feet.

Period		Group	Formation		THICKNESS	REPORTS OF
Devonian	UPPER	CONEWANGO		Sh, Ss, Cgl	0-600'	
		CONNEAUT	CHADAKOIN	Sh, Ss	0-600'	Oil
		CANADAWAY	UNDIFF.* •	Sh & Ss	700'-1200'	Oil
			PERRYSBURG#	Sh, Ss		Oil, Gas
		JAVA		Sh, Ss	100'-700'	
		WEST FALLS		Sh, Ss, Sh	415'-1950'	Gas
		SONYEA		Sh	45'-650'	Gas
		GENESEE		Sh, Ss, Sh	10'-900'	
	?		TULLY	Ls	0-80'	Gas
	MIDDLE	HAMILTON	MOSCOW	Sh	215'-790'	Gas
			LUDLOWVILLE	Sh		
			SKANEATELES	Sh		
			MARCELLUS	Sh		Gas
			ONONDAGA	Ls	20'-235'	Gas, Oil
	LOWER	ULSTER	SPRINGVALE	Ss	0-10'	
			ORISKANY	Ss	0-70'	Gas
		HELDERBERG	MANLIUS	Ls	0-220'	
			RONDOUT	Dol		
Silurian	UPPER	BERTIE	AKRON	Dol	0-45'	
		SALINA	CAMILLUS	Sh, Gypsum	403'-2295'	
			SYRACUSE	Dol, Sh, Salt		
			VERNON	Sh		
	MIDDLE		LOCKPORT	Dol	165'-250'	Gas
		CLINTON	ROCHESTER	Sh	123'-450'	Gas
			IRONDEQUOIT	Ls		
			SODUS	Sh		
			REYNALES	Ls		
	LOWER	MEDINA	THOROLD	Ss	0-15'	
			GRIMSBY	Sh, Ss	75'-175'	Gas
			WHIRLPOOL	Ss	0-25'	Gas
Ordovician	UPPER		QUEENSTON	Sh	715'-1010'	Gas
			OSWEGO	Ss	90'-675'	
			LORRAINE	Sh	560'-710'	
	MIDDLE	TRENTON-BLACK RIVER	UTICA	Sh	130'-270'	
			TRENTON	Ls	410'-525'	Gas
			BLACK RIVER	Ls	360'-470'	
	LOWER	BEEKMANTOWN	TRIBES HILL	Ls	0-50'	
Cambrian	UPPER		LITTLE FALLS	Dol	0-955'	
			THERESA	Dol & Ss	475'-860'	Gas
			POTSDAM	Ss	30'-365'	Gas & Oil-reported
PRECAMBRIAN			GNEISS, MARBLE, QUARTZITE, etc.			6/74 11/69

Fig. 1.--Composite Paleozoic stratigraphic section for western New York, west of long. 76°30'. (Auburn area)

•Includes Glade and Bradford 1st
▪Includes Chipmunk, Bradford 2nd, Scio, Penny
#Includes Bradford 3rd, Richburg, Humphrey, Clarksville, Upper Waugh & Porter, Lower Waugh & Porter, Fulmer Valley

The Medina averages 150 feet in thickness in Chautauqua County. From top to bottom the Medina Group consists of: Thorold Sandstone; a light-grayish-green, fine-grained sandstone which is 3 to 6 feet thick; Grimsby Sandstone, or Red Medina of the drillers, a fine- to medium-grained, red and grayish-white sandstone interbedded with red and green shales averaging 90 to 120 feet thick; Power Glen Formation of gray shale and interbedded gay sandstones which is 25 to 40 feet thick and wedges out towards the eastern part of the county and the Whirlpool Sandstone, or White Medina of the drillers, a light-gray to white, medium- to coarse-grained sandstone which is 8 to 14 feet thick in western Chautauqua County, but which thins towards the eastern portion of the county.

Productive Characteristics of the Medina Sandstone

Gas production occurs from scattered zones in the Grimsby in most fields, but high flows were encountered in the Whirlpool in Lake Shore and Sheridan Fields in Arkwright, Hanover and Sheridan Townships. Both Grimsby and Whirlpool produce gas in these two fields, but in the other 14 gas fields in Chautauqua County the Grimsby is the major gas producer with the Whirlpool producing only small amounts of gas. This is probably due to the thinness of the unit and also to the quartzitic nature of the Whirlpool. Gas accumulations occur where cementation of the sand grains has not obliterated porosity. Improved data from newer drilling indicates that minor structural features are imposed on the generally monoclinal, southeasterly dip and these appear, in some cases, to be related to the gas accumulations.

Gas flows reportedly have ranged from less than 100 Mcf per day to wells in Hanover Township which are recorded as having had natural flows of 8 to 12 million cubic feet of gas per day. Wells which were considered as dry holes in the early days are now routinely fracture treated to make successful producers. Many wells with natural open flows of 100 Mcf per day, or less, have been so treated to make producing wells. The porosity of producing zones in the Medina averages from 6 to 10 percent while rock (or surface) pressure in producing gas wells varies from 310 to 1200 psi, indicating that the Medina is an underpressured reservoir. Most rock pressures fall in the 550 to 850 psi range. It is estimated that at least 25 billion cubic feet of gas have been produced from the Medina in Chautauqua County to date.

Drilling and Completion Methods

Medina gas wells were drilled by cable tool rigs in the past but since the 1960's occasional Medina wells have been drilled by rotary rigs due to the declining numbers of cable tool rigs in service and to the greater speed of rotary drilling. In 1973, due to the commencement of a large-scale Medina drilling program in Chautauqua County, a number of rotary rigs were brought into the area and almost all Medina well drilling is now being accomplished by the rotary method. Current practice is to drill a surface hole through surficial, or weathered, material and run

11 3/4 inch, or 10 inch, casing cemented to surface. Some operators are drilling the surface hole with mud and are not running this surface casing or are using a temporary 12 inch galvanized iron casing. Intermediate, or water, string of 8 5/8 inch, or 7 inch, casing is then run to depths of 225 feet to about 400 feet (through known fresh water zones) and cemented in place. Finally, a 7 7/8 inch hole is carried to total depth and 4 1/2 inch production string is run through the Medina and cemented in place. The sand is then perforated through casing opposite productive zones determined by analysis of nuclear logs, fracture treated and shut-in for pipeline hookup and production. The size of current frac treatments averages 500 to 1000 barrels (21,000 to 42,000 gallons) of water and 30,000 to 55,000 pounds of sand. Breakdown pressures have varied from 2,000 to 4,000 psi. The total cost for a completed well varies between $40,000 to $50,000 per well.

Gas Prices

The wellhead price paid by the Utility companies for natural gas in New York remained stable at 30¢ per Mcf for many years but in 1972 was raised to 50¢ per Mcf and in early 1973 to 60¢ per Mcf. In the spring of 1974 this price was raised again to an annual average of 80¢ per Mcf. This price applies only to intrastate gas (gas produced and used within the state) and not to gas sold for interstate use. The Federal Power Commission, which regulates the price paid for interstate gas, has just approved an increase to 42¢ per Mcf for new interstate gas. In some cases higher prices than those mentioned have been obtained by selling gas to individual intrastate consumers.

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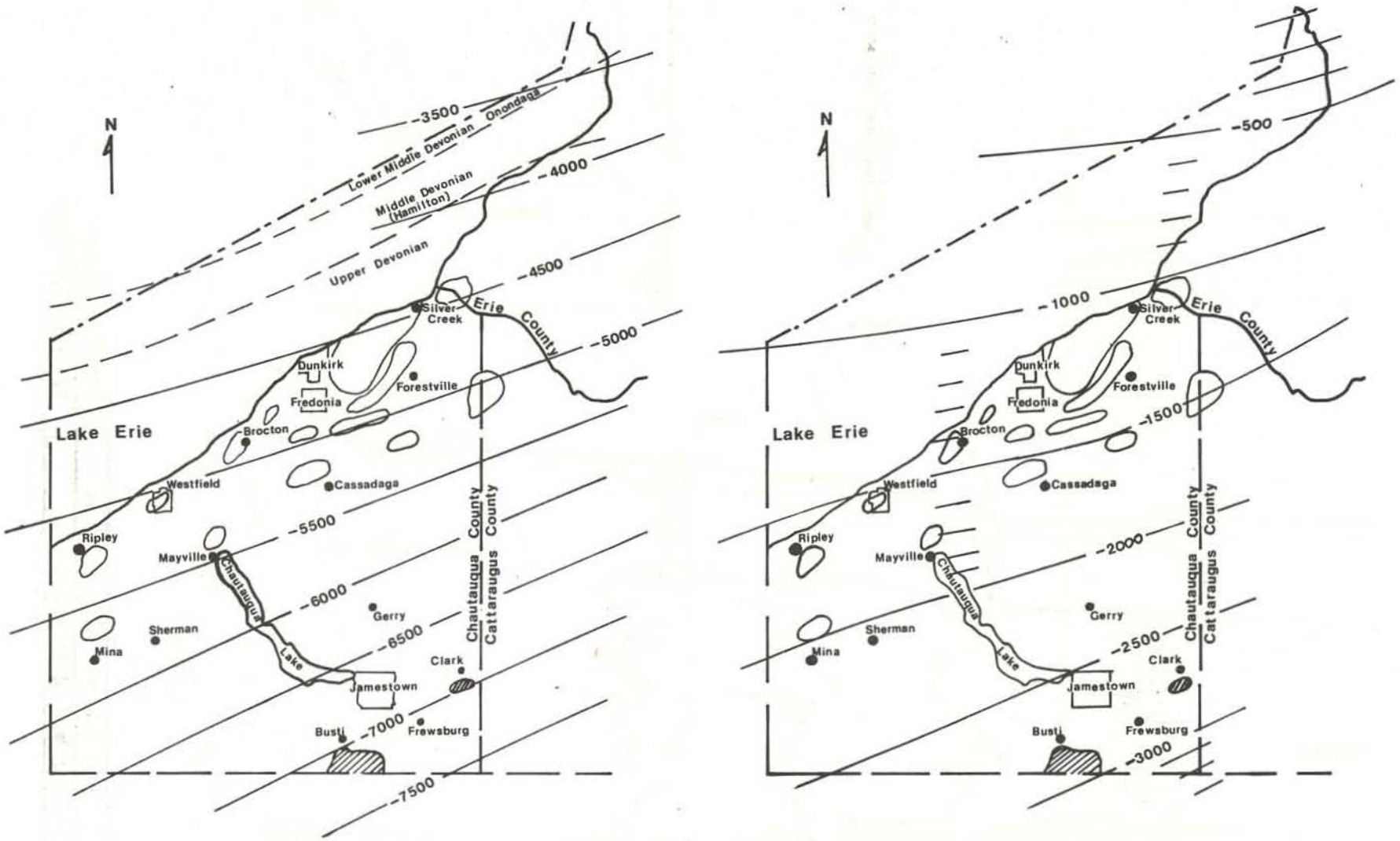

Figure 2. Subsea contours on top of (a) Pre-Cambrian and (b) Grimsby Formation

Gas field

Oil field

outcrop distribution, major units