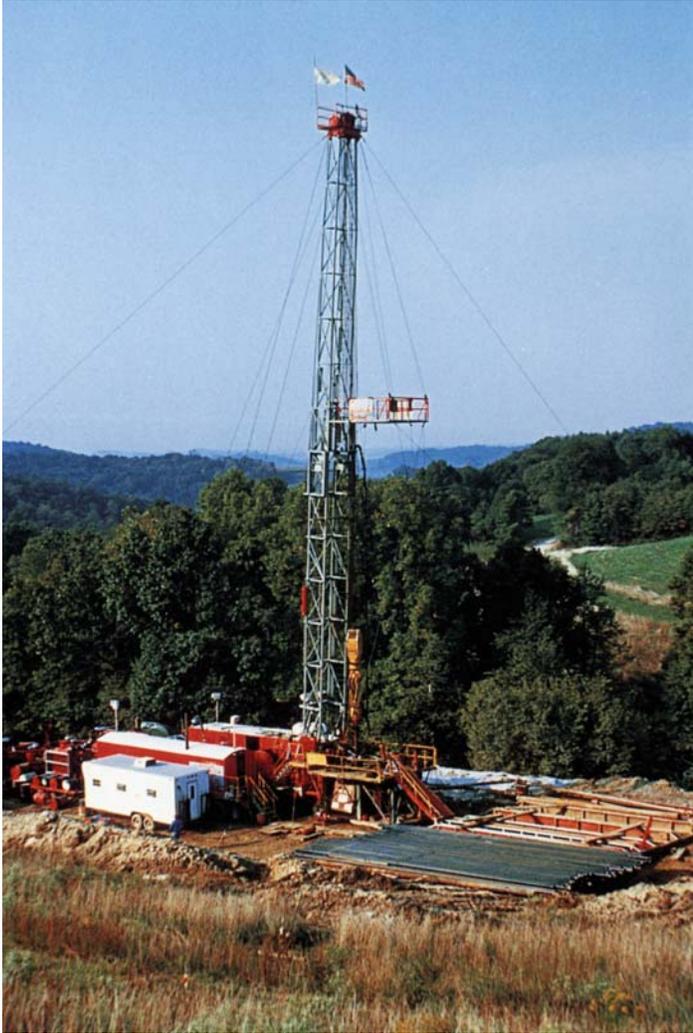


# Ohio Crude Oil and Natural Gas Producing Industry



*IDECO rotary rig drilling at 6000 feet,  
testing for oil and gas in the  
Beekmantown and Rose Run reservoirs.*

*Adams Township, Coshocton County,  
Ohio*

## BACKGROUND AND HISTORY:

The Ohio oil and gas industry has a rich heritage that dates back to the birth of the industry. Ohio lays claim to the first discovery of oil from a drilled well, when in 1814 a saltwater well driller discovered oil at a depth of 475 feet in Noble County. Ohio's first commercial oil well was placed into production in 1860 producing from the Macksburg sand in Washington County, preceded a few months by the famous Colonel Drake discovery in Pennsylvania. Commercial natural gas production began in 1884. Soon thereafter large-scale exploration and production of oil and gas began in Pennsylvania, New York, West Virginia and Ohio. Nowhere else in North America has commercial oil and gas production existed longer than that located within the Appalachian Basin and Ontario, Canada.

A century ago, when the Lima-Trenton field of northwestern Ohio was one of the largest U.S. producing provinces, Ohio was considered the "Middle East" of the oil and gas producing world. At its peak year of 1896, Ohio produced 24 million barrels of oil. Shortly thereafter a record was set in 1899 when 6,399 wells were drilled in the state. Obviously much has changed since the early days. But since that time a legendary entrepreneurial spirit inspired from the early explorers has been coupled with technology to open up vast oil and gas fields across the United States and the world.

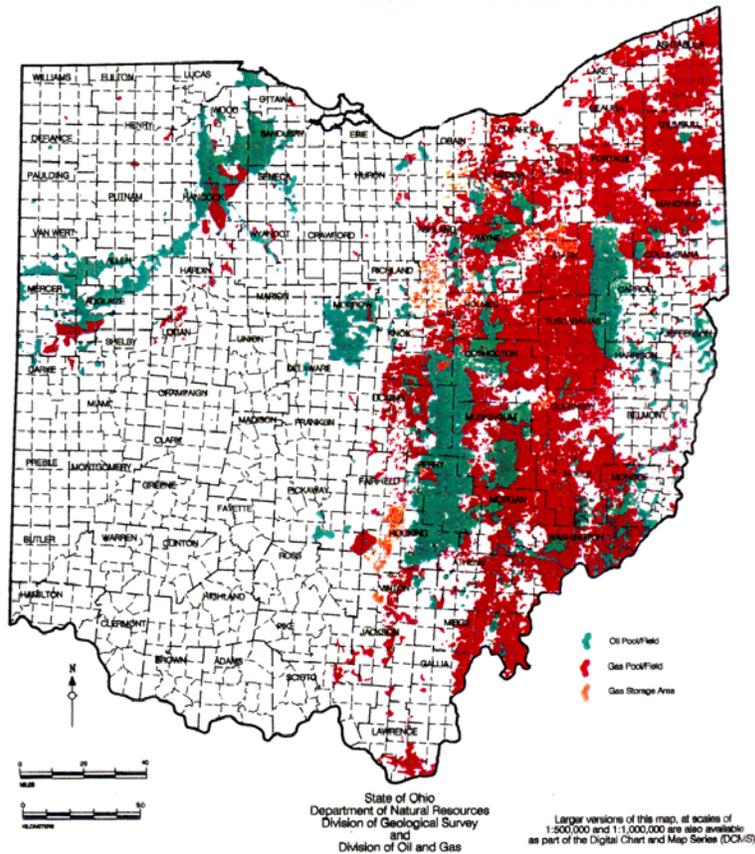
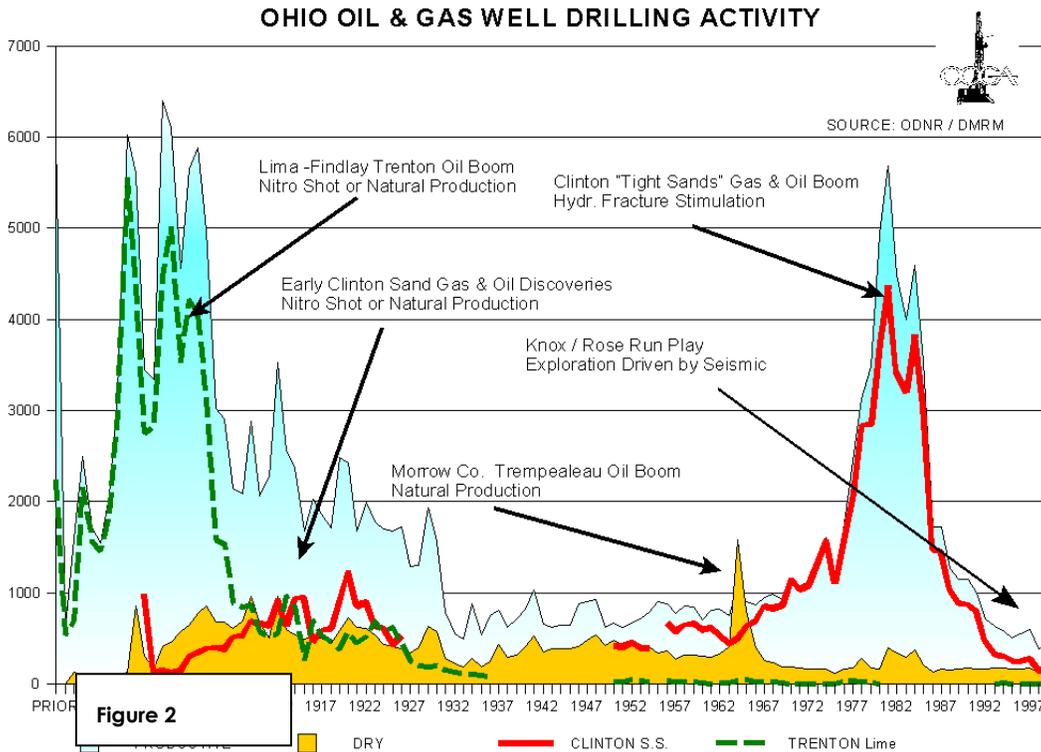


Figure 1: Ohio Oil & Gas Field Map

Ohio is blessed with numerous reservoirs offering oil and gas potential. These reservoirs are located over the majority of the state land mass. The drill bit has tested oil and gas reservoirs at depths ranging from less than 100 feet to over 11,500 feet. Many wells, particularly in southeastern Ohio, are completed in multiple reservoirs. **(Figure 1)**

Oil and gas production has been found in 76 of Ohio's 88 counties. During the past two decades wells have been drilled in 75 counties. For the most part however, oil and gas is produced in the eastern half of the state. To date, there have been over 268,000 wells drilled in Ohio, ranking the state as one the most active in the nation.

Typical of the oil and gas business, Ohio's industry history is one of major "boom and bust" cycles, each the focus of a geologic oil and gas play and intrinsically tied to commodity prices and technology. This history has evolved in several notable stages. **(Figure 2)**



**Figure 2**

1. Lima-Findlay Trenton Oil Boom: The Trenton limestone was discovered in 1884 at a depth of 1092 feet in Findlay, Ohio. The Trenton field made Ohio the nation's leading oil producer in 1896. That year 6,456 wells were drilled in the state. The Trenton is a vugular, highly permeable limestone that easily flushed prolific oil production. If needed, wells were stimulated by nitro-shot. Poor production and spacing practices condemned Trenton drilling by 1936.
2. Berea and Shallow Sands: During the same period, a variety of shallow sandstone plays, including the Berea, Big Injun, Cow Run, Germantown, Macksburg and Weir sands were exploited in various pools across eastern Ohio where good porosity and permeability were encountered. These wells often required nitro-shot stimulation to enhance production and well economics.
3. Clinton Phase One: In 1887, natural gas was discovered in the Clinton sandstone in Fairfield County. The discovery sparked natural gas and oil plays from high porosity Clinton fields located in the immediate area and, later, in the City of Canton field. The Clinton exhibited good economic potential. However, the Clinton generally displayed less than adequate permeability and usually required nitro-shot stimulation to produce economic production. By the late 1940s, dry hole rates approached 50 percent and most oil and gas operators believed that the Clinton was played out.
4. Introduction of Hydraulic Fracturing: During 1951, hydraulic fracturing stimulation of sandstone reservoirs met with success in Ohio. During a fracturing process, hydraulic pressure using water is applied to an oil and gas bearing rock to split the rock and create vertical drainage paths within the reservoir. These paths allow natural gas and oil to move more freely from the rock pores where they are trapped to the wellbore, where the product can then be lifted to the surface. As a result of fracturing, from 1951 through 1957 the Clinton success ratio increased to 85% completions and oil and gas producers renewed their interest in Clinton drilling.
5. Morrow County Oil Boom: In 1963, prolific oil was discovered in the Cambrian Trempealeau dolomite, primarily located in Morrow County. Several years of frantic drilling activity took place in Central Ohio, distracting attention from the Clinton. When productive, the Trempealeau is a vugular, highly permeable reservoir that traps oil within small anomaly structures that produce naturally.
6. Clinton Phase Two: Beginning in 1970 rising natural gas and oil prices, high demand for local supplies of natural gas, advances in fracturing technology, and the introduction in 1978 of the NGPA Section 107 "Tight Sands" incentive gas pricing and the Section 29 tax credit combined to create a massive drilling boom in the Clinton sands, as well as the Berea sands and Ohio Shale. Drilling activity within Eastern Ohio rivaled the early Trenton days. During the peak year of 1981, there were 6,085 wells drilled in Ohio, of which 76 percent were completed in the Clinton sandstone.
7. Since 1986, the collapse of oil prices and stagnant natural gas prices has challenged the survival of the Ohio industry. Even so, Ohio continues to be one of the more active drilling states. During challenging times, Ohio producers have been drilling deeper and taking on increased risk in a search for rocks that offer potential for higher rates of production. During the 1990's new opportunities of prolific oil and gas reserves have been found in the deep Ordovician Knox Rose Run sands, the Beekmantown dolomite and the Trenton Black River. Even so, the overall success rate for exploratory deep drilling is less than 50 percent.



## WHAT IS THE STATUS TODAY?

**Producing Wells:** Currently there are 62,960 wells producing oil and gas in Ohio. The great majority of these wells are classified as “marginal wells” – a term for wells that produce less than 10 barrels of oil per day or less than 60 thousand cubic feet of gas (Mcf) per day. These wells operate on the lower edge of profitability. Simple math says that the average Ohio well produces the equivalent of one barrel of oil per day.

Why should we be concerned with marginal wells? While each individual well contributes only a small amount of oil and gas in the aggregate they are a significant force. For example, there are 422,730 domestic marginal oil wells that combined produced more than 313 million barrels of oil in 1999 – 26 percent of domestic oil production. Ohio ranks 2<sup>nd</sup> among states in the number of marginal natural gas wells and 4<sup>th</sup> in the number of marginal oil wells.

**Reserves:** According to the Energy Information Administration, U.S. Department of Energy, for 2000 (the latest reporting year) Ohio has 1.179 trillion cubic feet (Tcf) of proved natural gas reserves and 51 million barrels of proved crude oil reserves. Ohio ranks 18<sup>th</sup> in crude oil reserves and 19<sup>th</sup> in natural gas reserves.

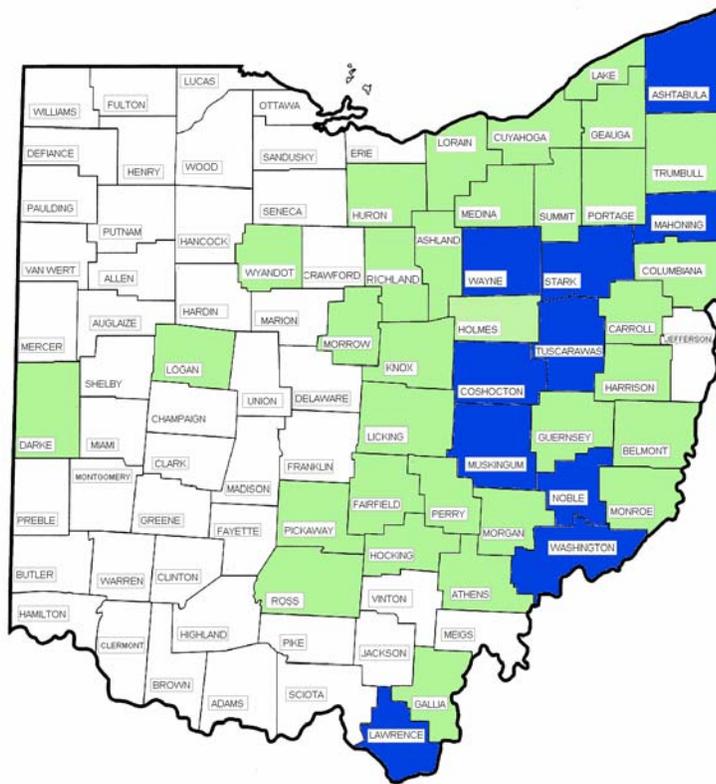
The Ohio Department of Natural Resources, Ohio Geological Survey recently issued a report that estimated an additional 1.1 trillion cubic feet of natural gas production may possibly exist in reservoirs underlying Ohio's portion of Lake Erie.

## WHO ARE OHIO PRODUCERS?

Virtually all Ohio producers are independent producers. Many are small, family-owned businesses. The oil and gas extraction industry employs 4,389 workers. Independents rely on revenues generated solely by their production and are thereby vulnerable to market volatility. Unlike major integrated oil companies, independent producers have no means of recovering production and regulatory overhead by passing those costs along to consumers through other operations, such as refining and marketing. Yet they must compete in global markets against foreign producers and governments who set prices not on free market factors, but rather, for political purposes that are frequently counter to American interests. Ohio producers are “price-takers” not “price-makers”.

U.S. domestic oil and gas production has changed over the years. Maturing fields and the need to respond to shareholder expectations have resulted in the major integrated oil companies shifting their exploration and production focus onto the U.S. offshore and to large producing fields in foreign areas. As this has occurred, the independents have filled the void.

Independent oil and gas producers drill 85 percent of all domestic wells, produce 65 percent of domestic natural gas and, in the lower 48, produce over 60 percent of domestic crude oil.



**Figure 3: 2001 Drilling Activity - Top Ten Counties in Blue**

**WHERE ARE OIL AND GAS WELLS DRILLED IN OHIO?**

Healthy upstream commodity prices from 2000 led to the second increase in the number of wells drilled in Ohio. According to the Ohio Department of Natural Resources, there were 677 wells drilled in 42 of Ohio's 88 counties. Muskingum County led the list of most active counties. Wells were drilled to depths ranging from 393 feet to 8,131 feet. **(Figure 3 & 4)**. Ohio ranks 7<sup>th</sup> in crude oil wells drilled and 14<sup>th</sup> in natural gas wells drilled.

The Clinton sandstone, an oil and gas reservoir prevalent throughout eastern Ohio, was the actively drilled zone. Clinton wells averaged 4,792 feet in depth. While it varies among operators and regions, the average Clinton well costs nearly \$175,000 to drill and complete.

Many Ohio producers are focused on exploration for new resources as the key to expanding the base of oil and gas reserves. Throughout the past decade that focus has been on the deep Knox Ordovician Rose Run sandstone. Rose Run drilling has been concentrated along a geologic phenomenon called the "Subcrop of the Knox Unconformity". Producers look to find "erosional remnants", which are small buried hills of the formation that often serve as an ideal mechanism to trap and accumulate oil and gas. **(Figure 11 - back page)**

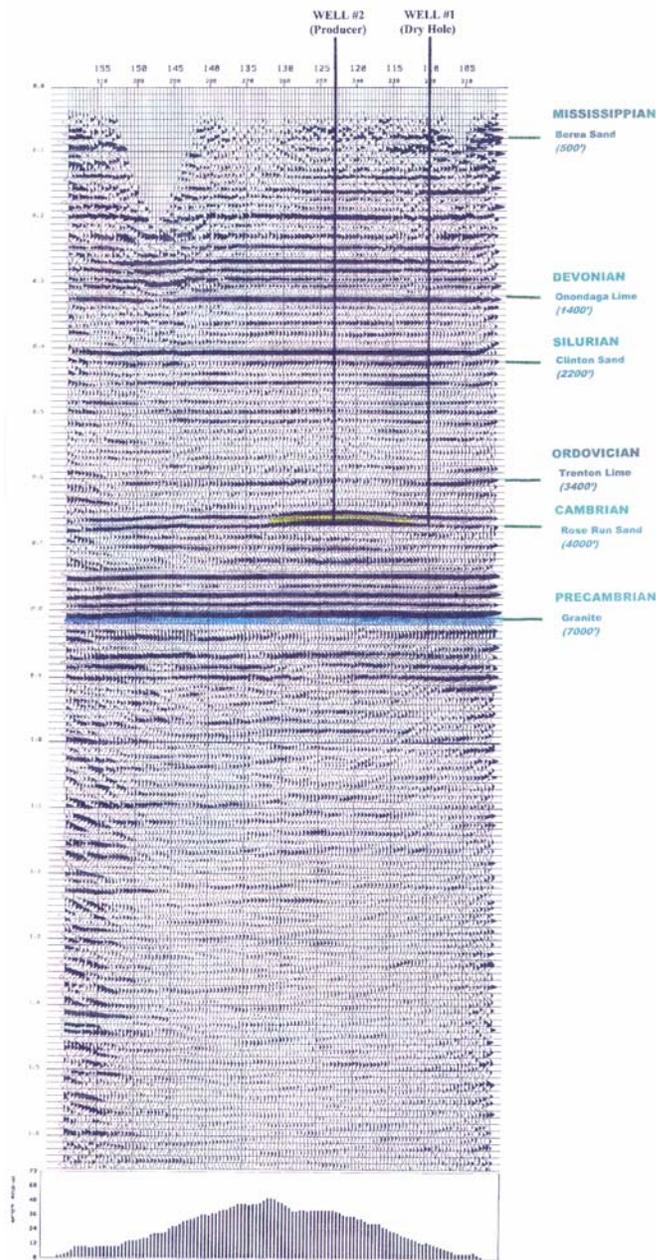
During 2001, there were 117 Rose Run wells drilled in Ohio. Rose Run wells averaged 5,739 feet. The cost to drill and complete a Rose Run well could easily exceed \$250,000.

## THE SEARCH FOR OIL AND GAS

The possibility of oil and gas production begins with geological and geophysical surveys to determine the probability of hydrocarbon recovery. For the producer, the challenge is to determine, as best as possible, if the chances are good that drilling a well in any particular location will result in commercial recovery of oil or natural gas. After all analytical tools are used, seeing is believing as the final step to discovery and reward always comes down to the same thing - a hole must be drilled to "test" if the reservoir truly exists - if oil and gas is present.

The oil and gas business is all about risk. In Ohio, for the producer risk becomes reality about 5,000 feet below the surface of the earth.

The dramatic increase in the success of Rose Run drilling has primarily occurred because the technology used to find immense oil and gas fields around the world has now been made accessible to the Ohio producer. In a large part, this is because computing power, particularly in seismic surveys, has become efficient and cost effective - to the point where even the small producer can take advantage of techniques that, only a short time ago, were reserved for use by large companies.



A seismic survey is the process of gathering information on underground strata in a specific area by recording and analyzing shock waves artificially produced and reflected from subsurface rocks.

Seismic information is obtained by shooting lines, usually straight, which are then processed and displayed in paper seismic sections. Similar to an ultrasound of a gestating baby, a seismic section is a diagram of a cross section of the earth - literally a picture of the subsurface of the earth.

## HOW MUCH OIL AND GAS DOES OHIO PRODUCE?

**Natural Gas:** During 2001, Ohio produced 98.2 million Mcf of natural gas (98.2 billion cubic feet), roughly equivalent to the volume of natural gas produced during 2000. **(Figure 5)** Increased commodity prices encouraged the drilling of new wells and the reworking of existing wells, halting the downward slide in natural gas production over the past decade. The peak year for Ohio natural gas production was 1984 when Ohio produced 186.5 million Mcf of gas. Over time, Ohio wells have produced more than 7.2 trillion cubic feet of natural gas production. Ohio ranks 17 among 32 natural gas producing states.

During 2001, the average wellhead price for natural gas, as reflected by the Appalachian Index was \$4.49 per decatherm. The ten-year average price is \$2.85/Dth. The average price for 2002 has been \$2.74/Dth. For the most part, Ohio producers receive a price for their gas pegged to major indicators that reflect the natural gas marketplace and impacted by the term of the contract, volumes committed and the time of execution. **(Figure 9)** Nevertheless, the driving force is the daily ebb of natural gas contracts traded on the floor of the New York Mercantile Exchange, in a volatile but transparent marketplace. Recent price trends show that natural gas is a commodity very sensitive to perceptions of supply, demand and weather.

Ohio is the nation's 7<sup>th</sup> largest natural gas consuming state. Last year, Ohio natural gas producers provided approximately 11 percent of Ohio natural gas consumption. That is enough natural gas to heat nearly 1 million homes for the year.

**Value of Local Production:** Local production – gas produced in our own back yard – is a safeguard that offers market protection against pipeline capacity and delivery constraints, particularly during peak demand periods. This represents a unique value to a state, such as Ohio, that is an industrialized large consumer of natural gas. Because of local production feeding into the eastern Ohio distribution system, Ohio citizens tend not to experience the extreme price swings caused by short-term peak-demand volatility that many other high-population centers suffered during recent years. This was recognized recently by one large Ohio utility which in a recent PUCO proceeding agreed to explore opportunities to increase the amount of Appalachian natural gas production to be added to its supply portfolio to mitigate firm transportation and capacity constraint costs.

**Crude Oil:** During 2001, Ohio produced 6.049 million barrels of crude oil. Crude represents about 30 percent of Ohio production. **(Figure 6)** Still, Ohio is the largest crude producer of the Appalachian states. While crude prices have recovered from the disastrous slide of 1998, the price coupled with uncertain market and political conditions have not encouraged producers to drill oil prospects. The peak year during the modern era was 1984 when Ohio produced 15.2 million barrels of oil. Over time, Ohio wells have produced over 1.087 billion barrels of oil. Ohio ranks 19 among 32 crude oil producing states.

For the most part, Ohio crude oil is paraffin based. At one time Ohio's "Penn Grade" crude was afforded a premium for its lubricant qualities. Advances in refining techniques and the chemistry of new lubricant products have erased that advantage.

Ohio crude is sold to two regional refineries, Ergon Refining located in West Virginia and American Refining Group located in Pennsylvania. Besides lube products, these facilities

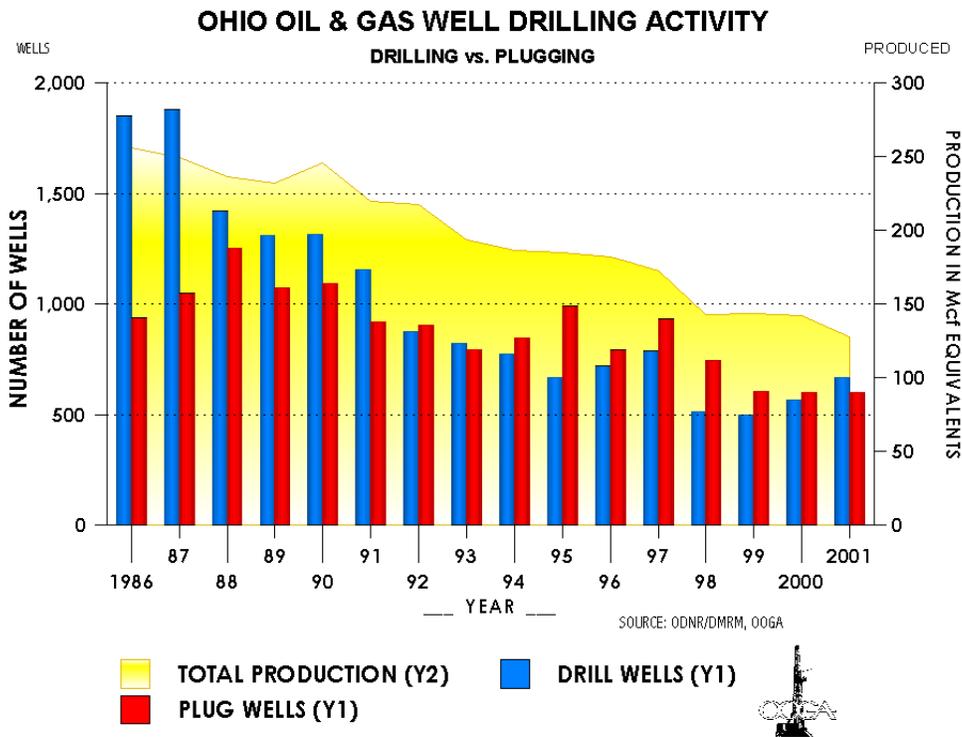
refine and market specialty products and some fuels. In the recent past, at least three refineries located in the Appalachians provided a market for Ohio-produced crude oil. None of the three operators that existed just ten years ago are now refining crude.

During 2001, the average crude oil price paid Ohio producers was \$21.84 per barrel of oil. The ten-year average price was \$18.19/Bbl. The average price during 2002 to date is \$19.19. The refineries that purchase Ohio crude regularly announce a “posted price” for crude that is less than the daily NYMEX price reported in the media – and what most people perceive to be the price of oil. **(Figure 10)** Over time this spread has grown from approximately \$2.25/Bbl to sometimes exceed \$3.75/Bbl. Some blame transportation and other costs for this spread or differential. Others blame the lack of a competitive marketplace for regional crude production. What is clear is that the crude oil marketplace is impacted by non-market forces and substantively lacks transparency.

The combined value Ohio crude oil and natural gas production during 2001 was \$573.6 million. This compares to the peak year of 1984 when value exceeded \$1 billion. **(Figure 7)**

During 2001, crude oil and natural gas production paid \$71.7 million in royalties to Ohio landowners and farmers. In addition, an estimated 982,000 MCF of free natural gas was provided to homes from wells located on landowner’s property – a \$4.4 million value. **(Figure 8)**

**Figure 4: Ohio Drilling Activity**



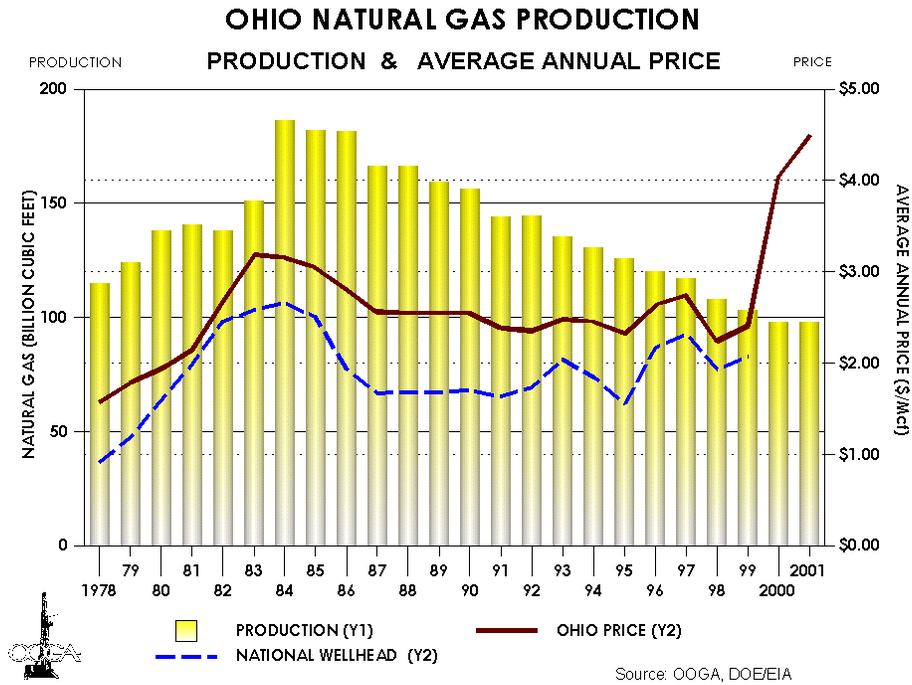


Figure 5: Ohio Gas Production & Price

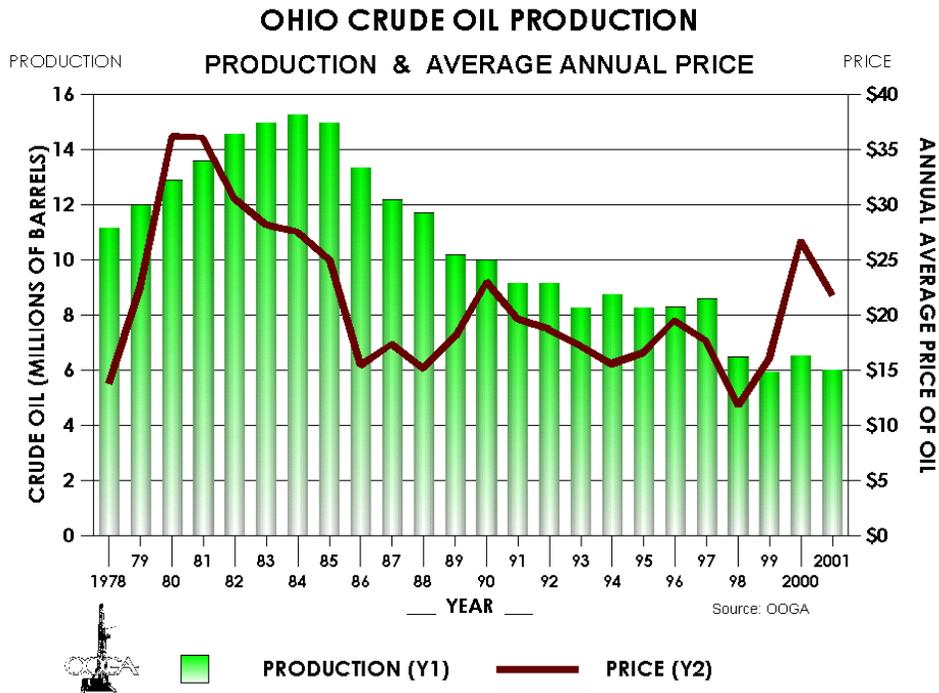


Figure 6: Ohio Oil Production & Price

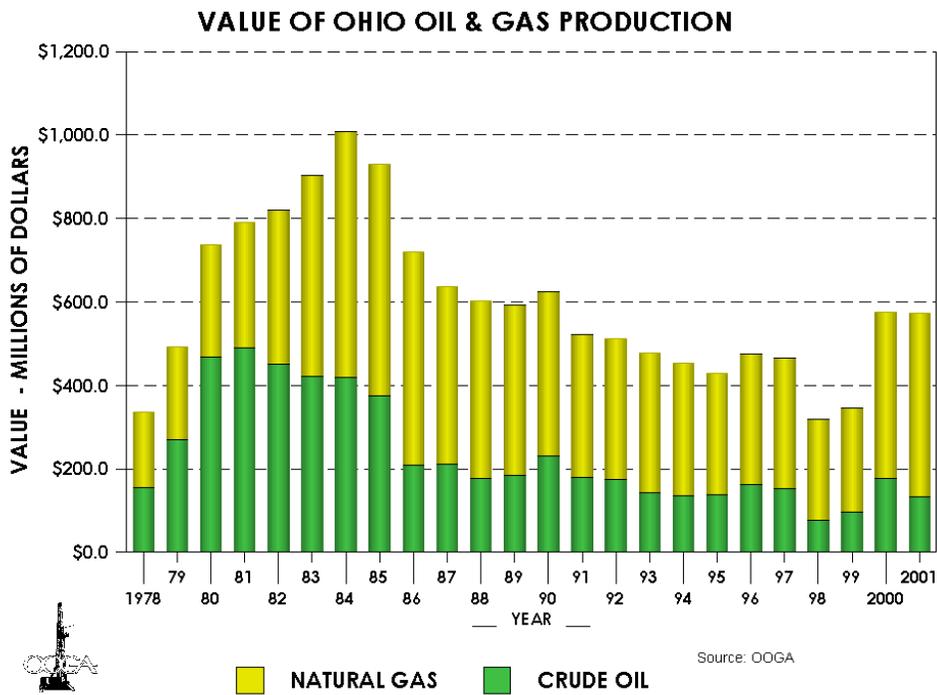


Figure 7: Value of Ohio Production

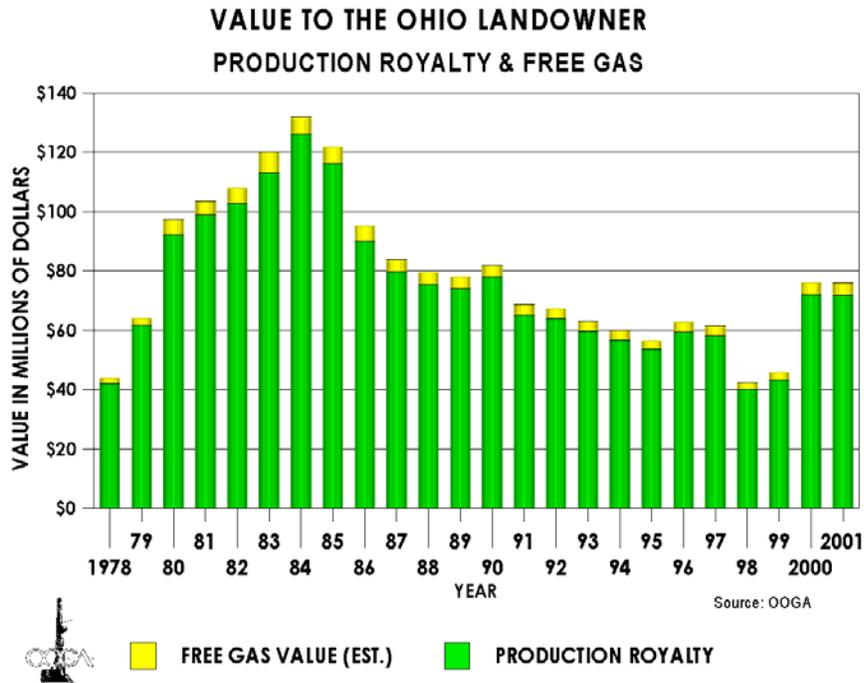


Figure 8: Value to Ohio Landowner



### NATURAL GAS INDEX PRICES NYMEX CLOSE v. TCo APPALACHIAN INDEX

A DECADE LOOK  
1991 - 2002

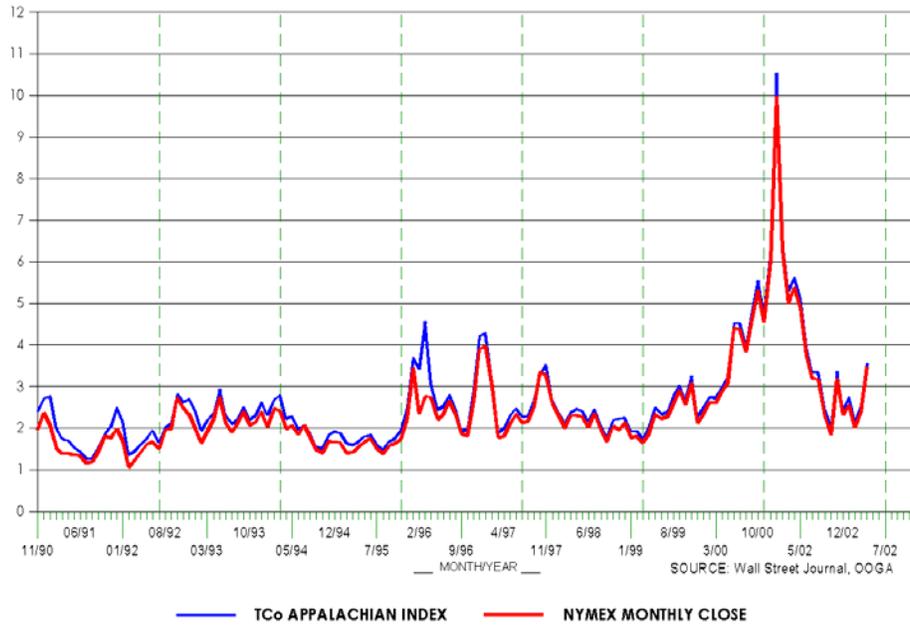


Figure 9: Natural Gas Prices

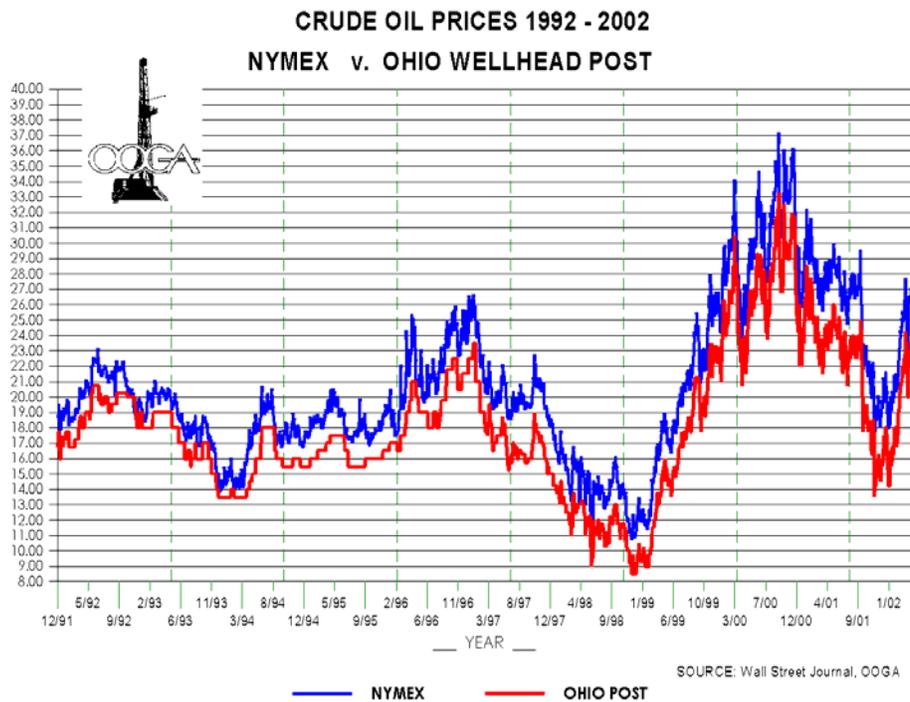


Figure 10: Crude Oil Prices

## **WHO REGULATES THE INDUSTRY?**

The Division of Mineral Resources Management, Ohio Department of Natural Resources (DMRM) is the primary agency authorized to regulate the Ohio oil and gas exploration and production industry. Statutory authority resides in Ohio Revised Code 1509. DMRM's mission is to ensure compliance with Ohio law and rules for oil and gas, coal and industrial mineral extraction; protect the public's health, safety, welfare and environment – particularly drinking water resources; and provide for the proper restoration of extraction sites.

During 1994, industry representatives joined with environmental and government officials to participate in the "State Peer Review", a critical review of Ohio's oil and gas exploration and production waste management regulatory program. After extensive study, the report, issued May, 1995, clearly stated that Ohio's regulatory program met the guideline requirements necessary for an effective waste management program, as established jointly by the Interstate Oil and Gas Compact Commission and the Federal Environmental Protection Agency.

A striking highlight of the Ohio State Review is that Ohio is one of the first states to initiate a program to fund plugging and remedial action of improperly abandoned wells. Many orphan wells date back to the early days of the industry and no owner can be identified. Ohio has one of the more progressive idle and orphan well plugging programs in the nation. Of the 29 oil and gas producing states, only Texas has plugged more wells than Ohio. The Ohio Idle and Orphan well program is funded by \$800,000 derived from producer-paid severance taxes.

**Taxes:** During 2001, Ohio's oil and natural gas producers paid \$4,253, 873 in state severance taxes. The DMRM oil and gas regulatory program is fully funded by producer-paid severance taxes and permit fees.

### **COMMENTS:**

The industry was coming off two "near depression" years, caused by the ruinously low oil prices of 1998 and 1999 when the natural gas marketplace exploded in the 2000-2001 winter. The oil and natural gas segments of our industry are inherently intertwined. Consequently, when oil prices plunged, producers imposed drastic reductions of exploration budgets - because drilling under those conditions made no economic sense. Gas exploration was adversely affected by the cuts, as well. Ohio reflected the nation in this trend.

During the bad times the industry lost approximately 65,000 skilled workers, and existing drilling rigs were cannibalized for equipment. Essentially, no new rigs were being built. While it is estimated that, nationally, we now have recovered approximately 40% of the workers, the skill levels of the new workers are often deficient, when compared to their predecessors.

Meanwhile, as the industry's capabilities were hard hit, natural gas demand continued to increase at a rate beyond all earlier predictions. Over 95% of new electric power plants planned, and being built across the country, are powered by natural gas. This trend reflects the federal policies of recent years, which have discouraged new nuclear, coal, and hydro projects.

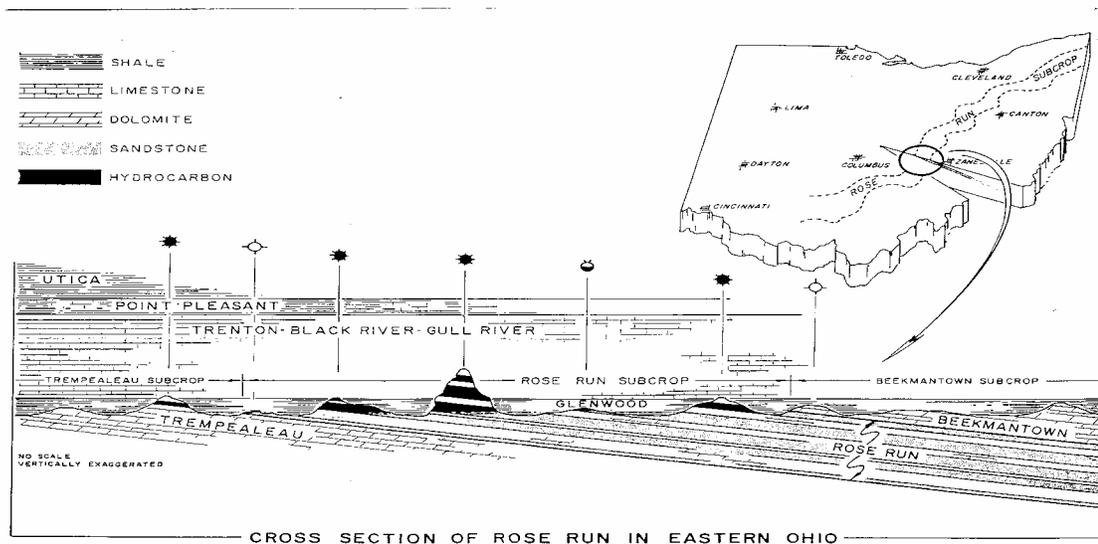
All of these factors combined to create the natural gas market situation that shocked the nation in 2001. At the time, the upstream industry quickly reacted to market indicators and began drilling wells. The national rig rate jumped to a high of 1278 rotary rigs during 2001. However, volatility and erosion of commodity prices beginning in the 2<sup>nd</sup> half, 2001 has caused the rig rate to drop to the current count of 766 – a 40 percent decline.

**The fundamental law of oil and gas business is this: Because existing wells deplete, the industry is sustained by the drilling of new wells. To be in the oil and gas business, one must both replace reserves produced and maximize conservation and recovery of discovered deposits. Drilling for oil and gas is a high-risk enterprise. However, without new wells to replenish reserves, production will decline and the industry will liquidate.**

Like it or not, the nation will be dependent on fossil fuels for the foreseeable future. The U.S. Department of Energy estimates that petroleum and natural gas will account for 66 percent of domestic energy consumption in 2015. A recent National Petroleum Council study projects that domestic demand for natural gas will increase by more than 30 percent by 2010.

The latest news of natural gas and crude oil price movements once again makes clear that the American energy marketplace operates within volatile cycles, the swings of which are coming closer to each other, the breadth more extreme. Ohio government and citizens deserve to understand why this happens and what can be done to mitigate the impact.

**OOGA is a statewide trade association with over 1,300 members who are actively involved in the exploration, development and production of crude oil and natural gas within the State of Ohio. The Association's mission is to protect, promote, foster and advance the common interests of those engaged in all aspects of the Ohio crude oil and natural gas producing industry.**



**Figure 11: Rose Run Sub Crop - Looking for Buried Hills**