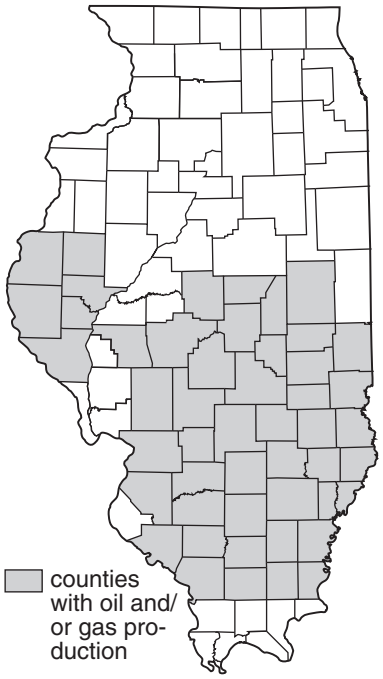
Illinois State Geological Survey

Geobit 9

Oil Fields in Illinois



Illinois has about 650 oil fields, primarily in the southern half of the state. You can recognize an oil field by the presence of "rocking" oil pump jacks and clusters of large storage tanks. Deep beneath this equipment—typically about ½ mile deep—lie one or more layers of porous rock called "reservoirs" that contain the "black gold." Oil flows from the reservoir into the 4- to 8-inch-pipe in the oil well.

Drilling for oil has always been a risky financial venture because fewer than half of the holes drilled in Illinois actually strike enough oil to repay the drilling costs. Unsuccessful wells, called "dry holes," are filled with cement and plugged to protect the groundwater.

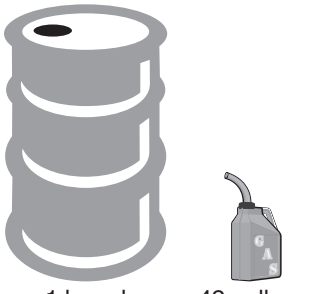
Illinois' drilling boom was in the 1940s and 1950s when the state was one of the nation's leading producers. In 1996, Illinois produced over 15 million barrels (630 million gallons) of oil; about 500 new wells were drilled, mostly to continue the development of known fields. In 1998, the average daily oil production from an Illinois well was only 1 to 2 barrels (42 to 84 gallons); but with 30,000 active wells, that adds up!

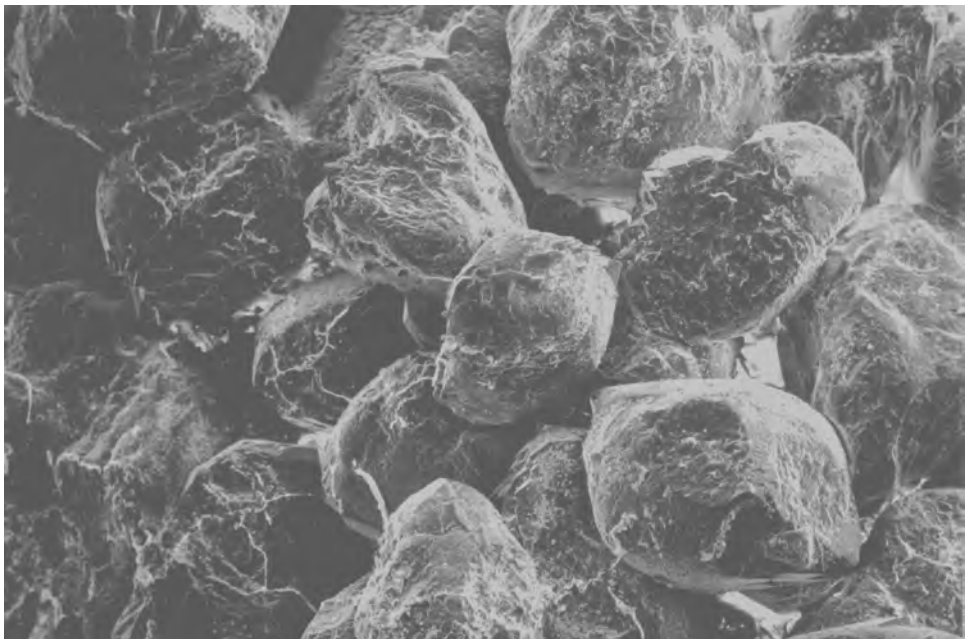
Where is oil found?

The oil reservoir is typically composed of layers of sandstone, limestone, or dolomite. The reservoir rock has tiny pores, and, in many cases, cracks or fissures, that are filled with oil, gas, and water. The pores and cracks are connected, so that when a well is drilled into the reservoir, the fluids in the pores can drain into the well.

Above an oil reservoir is a layer of shale or other fine-grained rock through which water or oil cannot pass. This layer acts like a seal or cap over the actual reservoir.

A typical oil well in Illinois. At the well head is the rocking pump jack (at the right). The oil-water mixture is pumped to the separator tank (center), and the oil then flows by gravity to one of the two storage tanks (left). The water flows to the other storage tank where it is collected and may be pumped back underground through an injection or disposal well. Photo by D. Morse.





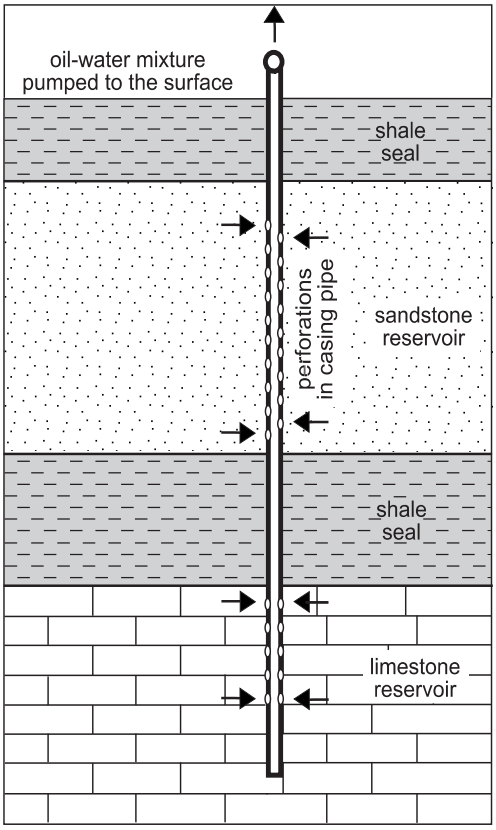
Grains of coarse sand from an oil reservoir, magnified 50 times by a scanning electron microscope. The oil-water fluid filled the spaces between the grains. Photo by B. Seyler.

Reservoir sandstone has individual sand grains that are slightly cemented together. Several sand grains could fit on the head of a pin, but there are still many pores or spaces between the grains that can hold oil. These sand grains were originally deposited in river channels and deltas or as sandbars and beaches in a shallow sea. Limestone reservoir rock may consist of sand-sized or larger fragments of corals, sponges, snails, clams, and other marine animals. Many ancient limestone reef deposits in Illinois contain oil.

Some Illinois reservoirs are found in dolomite. This rock is similar to limestone but has been chemically altered. The limestone has been recrystallized to form fine-grained dolomite, a process that may dissolve fossils and limestone to form large and small holes (pores) that can hold oil.

Getting the oil out

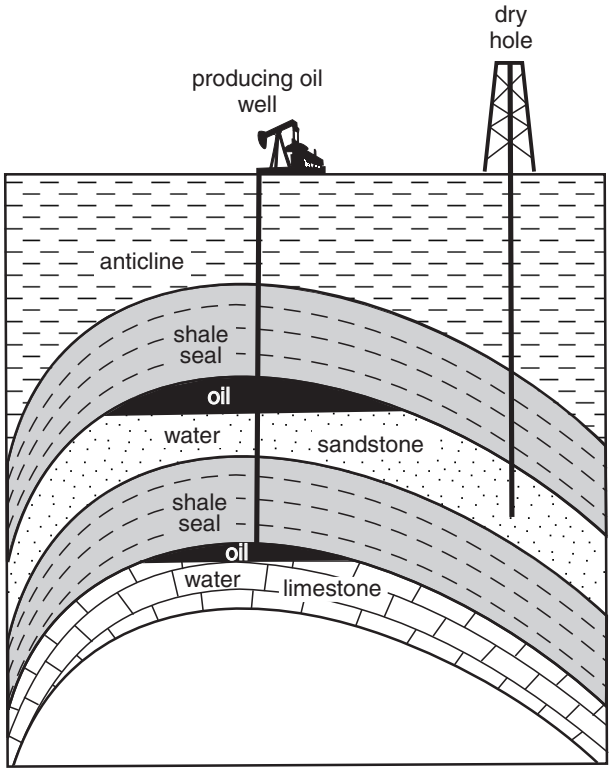
Deep in the well is a pump that is connected to the surface by long steel rods. When the pump jack at the surface is rocking up and down, it opens and closes valves in the submerged pump. Each stroke brings a cup or two of fluid up to the surface. This fluid, generally a mixture of oil and water, must be separated by an oil-water separator. The separator takes advantage of the fact that oil floats on water. Once separated, the oil is stored in large tanks before it is transferred by pipeline or truck to the refinery and the water is safely pumped back into the ground.



Arrows show the oil-water mixture as it moves from rock layers, through perforations in the well casing, and into the well bore. Finally, it is pumped to the surface through production pipe located inside the well casing pipe.

Where did oil come from?

Most of the oil in Illinois reservoirs came from layers of shale rich in organic matter, the remains of microscopic plants and animals that lived in a shallow ocean that covered Illinois about 360 million years ago. As the plants and animals died, their remains settled into the mud at the bottom of the ocean. Because the sediments and surrounding water contained almost no oxygen, the organic matter was preserved. This mud was buried and compressed beneath successive layers of sediment to form a rock called shale. Because the earth gets warmer with increasing depth, the shale eventually reached a temperature of about 200°F, when the heat began to break down the organic material— "cooking" the organic matter in the sediment and forming oil, which later migrated from the shale into the reservoir rock.



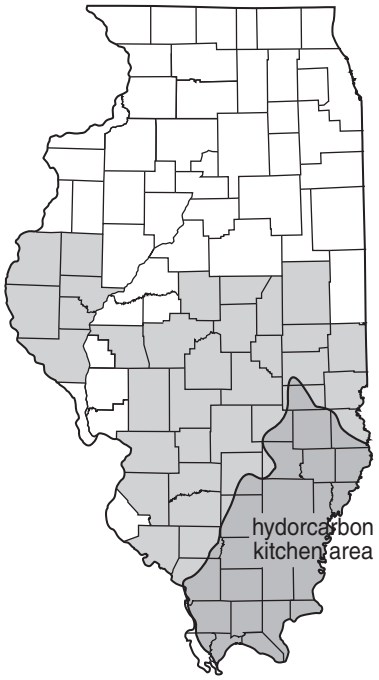
The folded rock layers trap the oil (black), which is lighter than water and floats at the top of the reservoir.

The hydrocarbon kitchen

Oil in the Illinois Basin is produced from a temperature-pressure zone called the "hydrocarbon kitchen." Here the most important organic-rich, oil-generating black shale in Illinois, called the New Albany Shale, was "cooked" enough to convert organic matter into oil. Oil was then expelled from the shale and migrated upward along cracks, fractures, or through porous and permeable-strata to the oil reservoirs. This migration is usually nearly vertical, and thus most of Illinois' oil fields occur in the area outlined by the "kitchen" boundary. Notice that oil is also found in reservoirs many tens of miles outside the kitchen. The oil reached these reservoirs through porous and permeable layers that acted like slightly inclined pipes that transported the oil far from the kitchen. Geologists say that the oil "migrated laterally" to these reservoirs. The oil fields in western Illinois are good examples of fields that required lateral migration.

Because oil is lighter than water, it tends to rise through the layers of the earth. If its way is blocked by a layer of shale or other impervious rock layer, the oil can move sideways through the pores and cracks in the rock layers until it is finally trapped in an upwardly arched bed called an "anticline" or against a fault plane; if the oil can reach the earth's surface, it forms a tar seep. One of the most famous seeps in the world is at the La Brea Tar Pits, which are located in Los Angeles, California.

When they explore for oil, geologists look for anticlines and other traps. Some of the anticlines in Illinois may be a mile or more across and several miles long. More than one layer of rocks in these folded strata might trap oil. Some of the biggest oil fields in Illinois have over 2,000 oil wells and contain over 200,000,000 barrels of oil; that is more than 8.4 billion gallons of oil.



Can you spot an Illinois oil field from the car? If you see pump jacks and storage tanks, you know that somewhere, deep underground, lies a layer of rock with oil in it.

Natural gas

Natural gas is another hydrocarbon fuel, but it is much less abundant than crude oil in Illinois. Few wells produce just natural gas here. Generally, gas in Illinois is a by-product that bubbles out of the oil when the oil is brought to the surface, where there is little confining pressure to keep the gas dissolved—a process similar to opening a can of soda and having bubbles of carbon dioxide released. Natural gas is separated in a gas separator and may be prepared for a gas pipeline, used to power the motor that runs the pump jack, or flared (burned) at the site to safely dispose of small quantities of this combustible material. Small yellow flames with dark smoke at the ends of pipes several feet off the ground near the separator and tanks dot an oil field where flaring occurs.

Contributed by David G. Morse

ILLINOIS STATE GEOLOGICAL SURVEY
615 East Peabody Drive
Champaign, IL 61820-6964
217/333-4747 FAX 217/244-7004

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