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Geochemist Says Oil FieldsMay Be Refilled Naturally

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Geochemist Says Oil Fields May Be Refilled Naturally

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COULD it be that many of the world's oil fields are refilling themselves at nearly the same rate they are being drained

by an energy-hungry world?

A geochemist at the Woods Hole Oceanographic Institution in Massachusetts says she believes that hitherto undetected gas and oil reservoirs lying at very great depths within the earth's crust could stave off the inevitable oil depletion much longer than many experts have estimated.

The scientist, Dr. Jean K. Whelan, whose research is part of a $2 million Department of Energy exploration program in the Gulf of Mexico south of New Orleans, has found evidence of differences in the composition of oil over periods of time as it flows from greater to shallower depths. By gauging degradative chemical changes in the oil resulting from action by oil-eating bacteria, she infers that oil is moving in quite rapid spurts from great depths to reservoirs closer to the surface.

Skeptics of Dr. Whelan's hypothesis acknowledge that oil is almost certainly flowing into certain reservoirs from somewhere, but say her explanation remains to be proved, as does the exact extent of the phenomenon.

A site in the gulf of particular interest to the Pennzoil Exploration and Production Company and several independent scientific teams, including Dr. Whelan's group, is Eugene Island Block 330, which is not an island but a patch of sea floor 700 feet beneath the water's surface. Discovered in 1972, an oil reservoir some 6,000 feet beneath Eugene Island 330 is one of the world's most productive oil sources; it has yielded more than one billion barrels, or 42 billion gallons, and is still going strong.

But Eugene Island 330 is remarkable for another reason: Its estimated reserves have declined much less than experts had predicted on the basis of its production rate.

Dr. Whelan's somewhat controversial hypothesis is a possible explanation.

Although the reservoir from which Pennzoil is pumping oil was formed at the time of the Pleistocene epoch less than two million years ago, oil now being recovered from the reservoir has a chemical signature characteristic of the Jurassic period, which ended more than 150 million years ago, Dr. Whelan said. The implication, she believes, is that highly pressurized oil from lower levels of "stacked" reservoirs is frequently breaking through geological barriers and "burping" upward, eventually reaching the reservoir from which oil is being pumped. The source of the pressurized gas Dr. Whelan believes to be powering the process is a bed of Jurassic period "source rocks," more than 30,000 feet deep, which are rich in very hot hydrocarbons.

Oil created during the Jurassic period from the decayed bodies of plants and animals that lived during the age of dinosaurs would initially have been a liquid, but in some cases, geological processes are believed to have gradually dragged oil reservoirs downward to great depths, where pressures are enormous and temperatures are greater than 700 degrees Fahrenheit. Under these conditions, oil is "cooked," decomposing into hydrocarbon gases consisting

mainly of methane.

The methane, however, cannot exist in its normal gaseous form at such pressures and temperatures, but is transformed into a "supercritical fluid" -- neither a gas nor a liquid but something in between. Large amounts of oil can be dissolved in supercritical methane, and the oil-and-methane mixture is probably capable of flowing upward from deep reservoirs through faults, cracks and geological "plumbing" to higher reservoirs. At the higher levels where temperatures and pressures are lower, methane can no longer remain in its supercritical state, and the mixture of gas and oil separates into its respective components.

"It could be," Dr. Whelan said, "that at some sites, particularly where there is a lot of faulting in the rock, a reservoir from which oil is being pumped might be a steady-state system -- one that is replenished by deeper reserves as fast as oil is pumped out." Extensive fault systems like those along the California coast might offer such a geological environment, she said.

The discovery that oil seepage is continuous and extensive from many ocean vents lying above fault zones has convinced many scientists that oil is making its way up through the faults from much deeper deposits. Faulting associated with such seepage is common along the Pacific Coast, in parts of the North Sea, and the Gulf of Mexico, among other areas, Dr. Whelan said.

The amounts and types of hydrocarbons lying at great depths are highly uncertain, because oil companies have

had little incentive to sink exploratory wells to depths of 20,000 feet or greater. The cost of drilling increases exponentially with depth, and there are still ample supplies of oil in relatively shallow reservoirs.

Dr. K. K. Bissada, a geochemist at Texaco Inc. in Houston, is doubtful that a true steady state exists in reservoirs that seem to be refilling themselves.

"I think we pump oil out much faster than oil can come in," he said. "But from a long-term perspective, I believe that hydrocarbons are coming in from great depths and are filling the newer reservoirs at shallower depths.

"It's impossible to put a number on the rate at which this goes on," Dr. Bissada said, "but I could imagine that this kind of stacked reservoir system, with favorable geologic plumbing between the reservoirs, might refill the upper reservoirs in, say, 10 or 20 years. If we were to go back to some old oil field that had been abandoned 50 years ago, we might drill a test well, and we might find fresh oil. The trouble is that that kind of experiment is too expensive in the present economic climate."

A recent report from the Department of Energy Task Force on Strategic Energy Research and Development concluded from the Woods Hole project that "these new data and interpretations strongly suggest that the oil and gas in the Eugene Island field could be treated as a steady-state rather than a fixed resource."

The report added, "Preliminary analysis also suggests that similar phenomena may be taking place in other producing

areas, including the deep-water Gulf of Mexico and the Alaskan North Slope."

Dr. Thomas Ahlbrandt, chief of the United States Geological Survey's Petroleum Geology Branch in Denver, is among many skeptics who believe that the Woods Hole hypothesis has not been demonstrated, although experts appear to agree that an increase in estimated reserves is occurring at many sites.

"I have the impression that although the people who drilled at Eugene Island encountered a fault plane," Dr. Ahlbrandt said, "they did not find oil coming up through it. On the other hand, drilling is a high-risk proposition, and the fact that it didn't produce oil doesn't necessarily make the hypothesis wrong."

There is much evidence that deep reserves of hydrocarbon fuels remain to be tapped. A recent estimate by the Geological Survey of "conventional" oil resources within the 48 states and state waters offshore has doubled America's estimated oil reserves since the last estimate was prepared in 1989. Dr. Ahlbrandt said that the estimate of continental American oil resources was 60 billion barrels, up from 30 billion in 1989.

But Dr. Ahlbrandt hastens to add that this does not mean that prospectors are finding large new oil fields; it means that "people are becoming more clever at finding and extracting hydrocarbons from previously overlooked resources."

This results from a trend oil experts call "field growth."

In some cases, he said, an oil company may discover an oil field, pump it almost dry, and then, using new seismic techniques that produce three-dimensional images of the fine details of deep geological structures, discover that an unsuspected and untapped extension of the field exists in some new direction.

In other cases, Dr. Ahlbrandt said, prospectors may find new reservoirs by drilling beneath old ones, penetrating salt barriers that had obstructed seismic probes. Finally, oil companies sometimes unknowingly drill right through oil-rich deposits on their way to reservoirs they had identified at greater depths. From such drill holes, oil is sometimes discovered simply by piercing the drill casing with a few holes at relatively shallow depths and analyzing the fluid that flows into the pipe.

But petroleum experts agree that no one has more than a vague notion of how much gas and oil remain in the world, or how long it will last.

The Geological Survey recently estimated that the world has about 1.7 trillion barrels of oil from conventional sources, enough for about 75 years at current production rates. However, if the consumption of oil should increase at a modest 3 percent annually, the survey estimates, production could be maintained for only about 31 years.

But Dr. Edward D. Porter, senior economist at the American Petroleum Institute, says that the uncertainties are so large that the implied precision of such calculations should not be taken seriously. "The estimate of world oil resources could

be off by as much as 700 billion barrels," he said.

Many past predictions have been wildly inaccurate. One of the better forecasts was made in the early 1970's by M. King Hubbard, a geologist, who predicted a peak in petroleum production in 1972, followed by a slow decline.

"Hubbard was pretty much correct about the trend of United States production, which has been declining during the last two decades," Dr. Ahlbrandt said, "but he extended that forecast to the world, and that was wrong. World production has not yet peaked, although many experts believe it will start declining in about 2015 or 2020."

The United States, he said, "is still the world's leading oil producer, although the Persian Gulf states own about two-thirds of the world's oil supply."

"They just curb their production rate," he added.

Possible improvements in technology could make a big difference, Dr. Porter said. New seismic techniques, in which sound waves are reflected or bent by geological structures, can now be interpreted to reveal very small oil reservoirs and other details of deep geological formations. Three-dimensional seismic technology, as well as measurements of the electrical conductivity of rock and other methods developed during the last decade "are as much better than old methods than is clinical magnetic resonance imaging better than conventional X-rays," he said.

Another imponderable is the future rate of oil and gas

consumption, he said.

To some extent, consumption depends on the price of oil, but this, Dr. Porter said, is impossible to predict. Production curbs by oil-producing nations have effects on price that can be easily calculated, he said, but in the absence of such constraints, "the price of oil fluctuates chaotically."

Future prices will affect not only consumption but the willingness of oil companies to invest in the extraction of petroleum products from nonconventional sources -- tar sands, heavy oil and perhaps even shale. Experts estimate that 10 times as much petroleum is tied up in such sources than in conventional reservoirs, but the cost of recovering it is high.

The research needed to develop new sources is also expensive, and oil companies, together with many American industries, are reducing such expenditures.

"Everyone is scaling back research," said Dr. Bissada of Texaco.