Drilling Into a Deep Controversy

By RICHARD MONASTERSKY

As the drill bit slowly advances, cutting through 6,000 meters of solid granite, an anxious drill team waits above, in a verdant Swedish forest thick with pine. They come to this geologically unpromising location in search of natural gas. If they find commercial quantities, geologists will have to revise their explanation for the origin of oil and gas—a revision that could mean the earth holds untold reserves of these precious fuels.

Most geologists believe that natural gas and oil originate from the decay of buried organic material, hence the name fossil fuels. Dead ocean organisms such as plankton and kelp sink to the ocean floor and are covered by layers of sedimented rock particles. Then, as sediments accumulate over organic layers, pressure, temperature and time break these organic molecules into the heavy hydrocarbons of oil and then into the lighter hydrocarbons of natural gas.

Since 1979, astronomer Thomas Gold has attacked this conventional theory by reviving a century-old idea that the principal source of oil and gas is not organic material but the interior of the earth. The modern version of this alternate theory, called the deep-earth-gas hypothesis, begins with the earth's origin.

Gold, formerly with Cornell University in Ithaca, N.Y., claims that the primordial earth received most of its carbon in the form of complex hydrocarbons, which can still be found in many of the meteorites that bombard the earth today. As the earth developed and warmed, the hydrocarbons buried within the mantle began to liberate methane, the lightest of the hydrocarbons and the principal component of natural gas. Gold contends that since this early warming, methane and heavier hydrocarbons have been rising to the surface of the earth through open areas of the crust such as volcanoes and fault lines.

Lack of evidence has kept most geologists from seriously considering this highly speculative theory. At the same time it has been difficult to disprove the deep-earth-gas hypothesis. Right now, however, many eyes are focused on a 44-kilometer-wide Swedish meteor crater named the Siljan Ring, where an ongoing drilling project might provide Gold with much of the evidence he needs.

While the drilling project, which includes scientists from the United States, Sweden, Germany, Denmark and Norway, has yet to strike a large methane reservoir, the scientists have already found small amounts of methane and other evidence that might vindicate the deep-earth-gas hypothesis. Even the interpretations of these preliminary findings, however, have run into opposition in the scientific community.

Geologists, as a rule, would never expect to find large quantities of methane under the Siljan Ring, and many have argued that drilling there would be futile. These conclusions are grounded in the type of rock that underlies the crater. Because the conventional theory of fossil fuel formation requires buried, organic sediments, geologists look for these fuels only in or near sedimentary rock. However, the rock within the crater is granite, an igneous rock formed by the solidification of molten rock, or magma.

If Gold is correct, though, and hydrocarbons do rise from the mantle, then the ring is an ideal place to find what he proposes is deep-earth, nonbiological gas. Gold surmised that the comet impact around 362 million years ago cracked the ground, and has provided conduits through which mantle gas has been rising. Fissures near the surface have since been naturally sealed by cement-like calcium carbonates, but deeper regions underneath should have remained porous, creating a place for methane to accumulate, says Gold.

Tests conducted before the drilling began indicated that a large zone of porous rock does exist under the ring. And earlier this year, two events indicated that the drilling crew had reached such a zone. At 6,000 meters the drilling rate increased rapidly for a meter, as the drill cut through a soft region in the granite. At the same time over 37,000 gallons of drilling lubricant quickly drained into the porous region. Normally, this lubricant, which is used to remove cuttings from the drillhole, circulates through the drillhole without loss.

Some liquid or gas must have been stored in this porous zone to prevent the zone from being closed by the weight of 6,000 meters of solid rock overhead, says Ferol Fish of the Gas Research Institute, a Chicago-based organization that is providing part of the funding for the project. Whatever was originally present in the porous rock was displaced by the high-density drilling fluid. "We don't know whether the [original] fluid was a liquid or a gas," says Fish. "It's more likely a gas because the drilling fluid went into the formation so fast."

Since then, equipment problems have stalled drilling progress, but the drilling team is presently attempting to repenetrate this porous zone in order to sample whatever fluid was present.

Even if large quantities of methane are not found, several results from the drilling project support the deep-earth-gas hypothesis, says Gold. For one, small amounts of methane and hydrogen, another combustible gas, have been found in the drilling fluids from the Siljan project.

Further evidence comes from analysis of the carbon found in the calcium carbonate cements which fill the cracks in the Siljan granite, says Gold. This carbon contains anomalously low concentrations of carbon-13, and must have come from hydrocarbons rising from the earth's mantle, he says.

However, others have disputed whether these results actually support the migration of methane from the mantle. Finding gasses in the drilling fluid does not prove that they originated in the mantle, says John Valley of the University of Wisconsin at Madison, who has been analyzing samples from the drillhole. Since the process of drilling exposes water from the drilling fluid to reduced iron filings from the drilling bit, "some of the hydrogen and quite possibly some of the methane as well are forming as an artifact of the drilling," says Valley.

Valley also believes that the anomalous carbon-13 ratios can be explained without invoking deep-earth methane. Groundwater in other areas of Sweden contains bicarbonates that display similarly low ratios of carbon-13, "and these bicarbonates have a surface origin in the peat bogs or pine forests," says Valley. Instead of mantle methane supplying the carbon for the calcium carbonate cements, it is more likely, he says, that circulating groundwater provided the carbon in the form of dissolved bicarbonates.

"Of course," says Valley, "the dominant test is whether or not we strike gas. If we strike gas, then all the rest of this is academic."

A gas strike at the Siljan Ring would force geoscientists to reconsider the explanation of the origin of petroleum and natural gas that has held dominion since the early part of this century. "This would be something like an earthquake in the conventional science establishment. People would have to go back to the drawing board . . . and ask what is the origin of it," says Martin Schoell of the Chevron Oil Field Research Company in La Habra, Calif.

Such a strike would not prove that oil and gas rise from the mantle, but it would raise the possibility that igneous and metamorphic rock contain significant reserves of oil and gas — an untenable statement in the past. "It would open up an exploration frontier in these types of rocks," says James R. White of the Department of Energy's Office of Fossil Energy.

White cautions, however, that the existence of these reserves and their accessibility both remain important unknowns in this field. "For that," he says, "we'll have to drill." □

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