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Under All That Ice, Maybe Oil

Martin Jakobsson for The New York Times

Last August, three icebreakers moved into position to extract the first deep cores of sediment beneath the drifting ice cap in the Arctic Ocean near the North Pole.

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The ice-cloaked Arctic Ocean was once apparently a warm, biologically brewing basin so rich in sinking organic material that some scientists examining fresh evidence pulled from a submerged ridge near the North Pole say the seabed may now hold significant oil and gas deposits.

This is just one of many findings from a pioneering expedition that in late summer sent dozens of scientists and technicians on three icebreakers - one with a drilling rig nine stories tall - into the drifting, crunching plates of sea ice to retrieve the first long-term record of climate and ocean conditions there. The expedition drilled 1,400 feet deep, retrieving cores of sediment that, with some gaps, span 56 million years. Scientists from around the world gathered in Bremen, Germany, this month to analyze the samples.

They hope that a better understanding of how Arctic climate has varied over the millenniums will help them project the implications of the region's recent warming trend, which many scientists have concluded has mainly been propelled by emissions of carbon dioxide and other heat-trapping gases.

Just retrieving the samples was "a technical tour de force," said Dr. Richard B. Alley, an expert on Arctic change at Penn State.

And the initial findings are already upending old notions, among them that the Arctic Ocean lacked sufficient sediment and biological activity to record past conditions in its bed.

"Everyone thought this ocean basin was starved of sediment," said Dr. Kathryn Moran, an oceanographer at the University of Rhode Island who was a co-leader of the 14-nation project. "We've already knocked that ball out of the park."

So far, the coring project has mainly garnered the attention of climate experts, but word is slowly spreading among geologists focused on oil as well.

Petroleum deposits are already charted along the shallow shelves fringing the Arctic from the North Slope of Alaska to northernmost Europe. But the cylinders of dark, ancient rock extracted from the submerged mountain range, the Lomonosov Ridge, are the first hint that such deposits may lie in the two-mile-deep basins near the top of the world.

The cores provide the first evidence that vast amounts of organic material created by plankton and other life settled on the seabed, experts say. That kind of carbon-rich accumulation is a vital precursor to the formation of oil.

Some of the deepest, oldest, most carbon-rich layers, dated to around 55 million years ago, formed during a period called the Paleocene-Eocene Thermal Maximum, when the world was running a raging temperature. Scientists believe that

this relatively brief period, far warmer than the present, was caused by a spike in heat-trapping greenhouse gases far greater than the human-caused buildup that has occurred over the last century.

The cause of the warming was a vast release of submarine deposits of frozen methane, a powerful greenhouse gas, but scientists do not yet know whether the methane was liberated by volcanic activity, a shift in warm sea currents or some other force.

About 49 million years back, with the climate cooling and the atmosphere's greenhouse burden declining, the retrieved shafts of sediment also speak of an extraordinary, short-lived era of several hundred thousand years when so much warm fresh water apparently topped the Arctic's oxygen-starved salty depths that the polar sea became matted with tiny Azolla ferns, resembling the duckweed that can choke suburban ponds.

Altogether, about 600 vertical feet of sediment from the ridge is rich dark organic material, implying that there could easily be two vertical miles or more of similar organic layers in the deeper adjacent basins, said Dr. Henk Brinkhuis, a geobiologist from Utrecht University in the Netherlands who participated in the coring project.

If subsequent accumulations of sandstone and clay formed the appropriate lid, the deeper material could have cooked into oil or gas, he said. He stressed that this remained "crude speculation" until more surveying was done. But with demand for oil skyrocketing and known reserves dwindling, even the subtlest hint is significant.

"This could indeed be a promising sign for oil and gas prospectivity in the Arctic Ocean," said Prof. Harry Doust of the Free University of Amsterdam, who is a former exploration geologist for Shell.

He, too, stressed that more drilling would be needed before anyone could contemplate an eventual oil boom in the deepest Arctic. "Nevertheless, oil prospectors will be very excited," he said, "and will be watching the results of analyses with keen interest."

Already, under a provision in the Law of the Sea Treaty, Denmark, Russia and other countries with Arctic territory are sending out mapping expeditions aimed at expanding their seabed claims. The United States, under pressure from some conservative Republican senators who oppose many such international compacts, has not ratified the treaty. But new American Arctic surveys are planned, in part on the presumption that the United States will ratify the treaty soon.

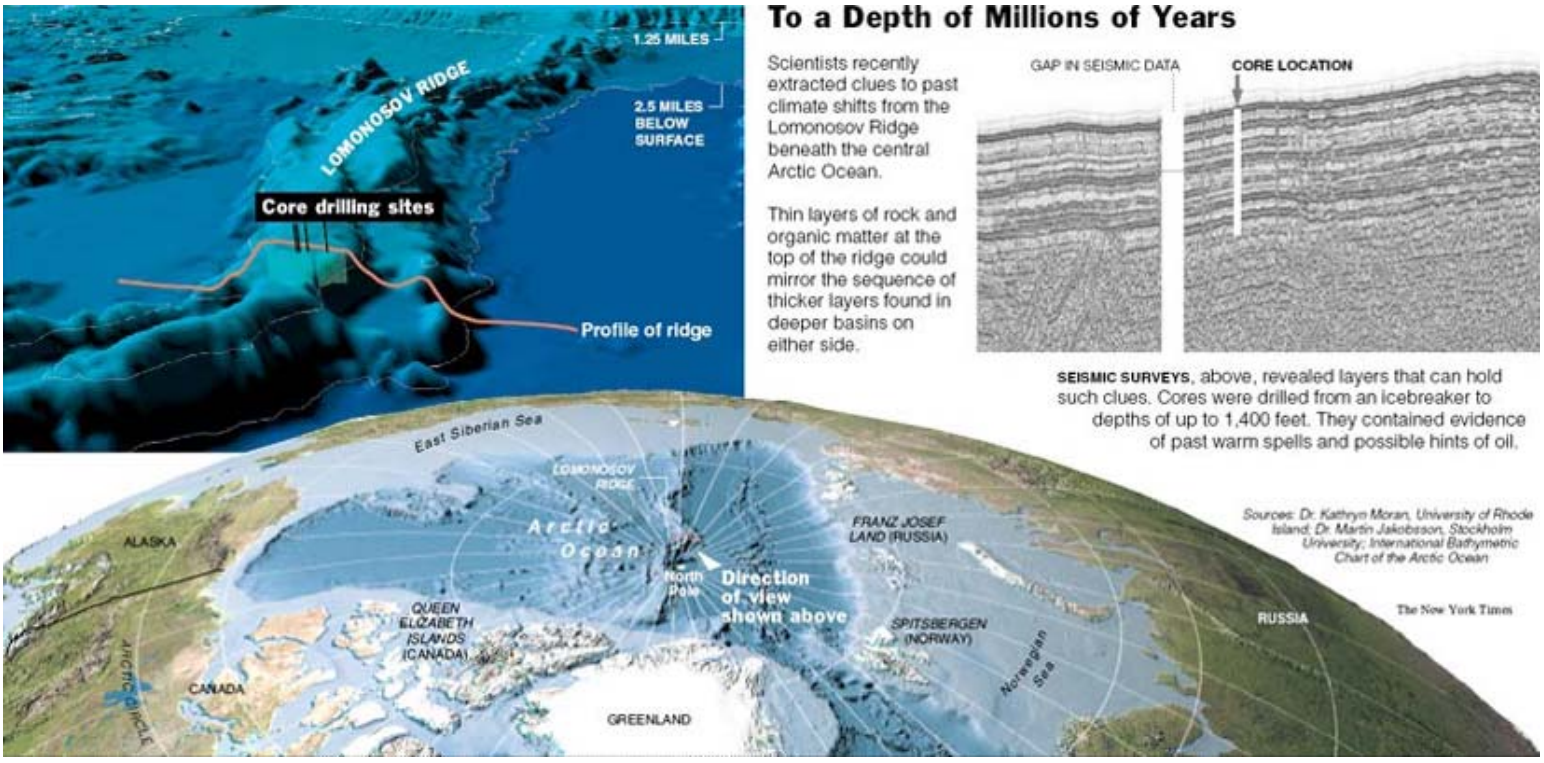
For the moment, any long-term implications of the research for oil markets are secondary to the scientific value of the cores, Arctic experts said.

The preliminary analysis reveals that the Arctic Ocean has been constantly icy for at least 15 million years, far longer than scientists had previously theorized. Dr. Moran said scientists had previously put the last ice-free conditions at four million to seven million years ago.

Experts involved in the work said these findings added sobering context to today's Arctic warming trend, which climatologists have linked to accumulating greenhouse gas emissions and say could lead to a largely ice-free sea in summers this century.

No one expects ferns to cover the polar sea anytime soon, but some experts involved with the research said the recent changes in the Arctic could result in a long-lasting warming that is likely to change the nature of the Arctic profoundly, for better and worse. In outlining the pattern of change during and after the last big Arctic warm-up, 55 million years ago, the new cores show "you can get a really strong cascade" toward warming that can then take hundreds of thousands of years to reverse, said Dr. Brinkhuis.

Whatever the future holds, it is becoming



clearer with every new scientific poke at the freshly recovered shafts of layered shale, microscopic plankton fossils, pebbles and other material that the coring project will provide an unparalleled view of past climate changes at the top of the world, Arctic experts said.

"This information will be extremely valuable for placing the recent observations of Arctic change in the proper context," said Dr. Peter Schlosser, who is not involved with the project but is the current chairman of the National Science Foundation's Study of Environmental Arctic Change and a researcher at Columbia. The coring expedition took a decade to plan and grew out of a series of seismic surveys, starting in 1991, that bounced sound waves more than 1,000 feet into the Lomonosov Ridge and pictured the kind of layer cake striations that can reveal climate and ocean history. The ridge, four Eiffel Towers deep, was chosen instead of the deeper sea floor in part because such features - rising as high above the seabed as the Alps rise over Europe - tend to accumulate the neatest layers of deposited debris over time, without slumping and other movement that can scramble geological evidence elsewhere, Dr. Moran said.

The sediment layers on a ridge also tend to present a compressed version of geological and climatic history, like a Reader's Digest condensation of a novel, meaning that a core need not penetrate deeply to capture the whole story, some of the researchers said.

The $12.5 million project was conducted under the auspices of the Integrated Ocean Drilling Program, which is coring seabeds around the world to reveal geological history.

From mid-August through early September, two icebreakers ran interference for the vessel with the drilling rig on its deck, trying to fend off the thickest floes so the drillers could remain motionless while bringing up dozens of shafts of ever-deeper sediment in sections 15 feet long.

While the greatest concern had been defeating the ice, the main impediment to getting samples was a lack of certain equipment and fairly mundane breakdowns, scientists on the project said.

Henk Brinkhuis

Layers around 1,000 feet down and 49 million years back in time held spores of the Azolla genus of water fern, above, varieties of which still cover ponds today.

After nearly three weeks, they finally accumulated a series of cores cutting through all the sediment that had accumulated on the ridge since it broke off from the continental shelf between Europe and Greenland some 57 million years ago and began to subside and drift toward the North Pole.

The sediment, building on the bedrock over tens of millions of years, acts as a climate chronology, including thick organic layers of fossilized fern spores and plankton skeletons from the warm eras and speckled layers of coarse sand and pebbles that could only have gotten there if they had been carried from coasts by drifting sea ice and rained down as the ice melted.

The initial analysis looked only at small samples taken every 15 feet, Dr. Moran said. But even in that subset of the material, the big patterns of Arctic history leaped out, she and others said.

One of the most remarkable revelations is that the Arctic Ocean apparently briefly bloomed into a great matted soupy superlake. Dr. Brinkhuis, who previously worked for oil companies, said that previous drilling efforts by oil teams around the perimeter of the Arctic also captured this brief flowering of water plants, but no one had conceived that the layer might hint that the entire Arctic basin was one great matted pond.

"It's spectacular," he said. "Right at this transition from supergreenhouse to cooling, that's where there's this evidence of a bathtub situation there that is so fresh that this Azolla can really bloom and boom."

He said it was possible that the fast-growing plants, by absorbing huge amounts of carbon dioxide, might have contributed to the eventual decline in the atmosphere's greenhouse gas concentration and climate cooling.

But he and many other experts said that much more research, and sampling, would have to be done, given the limits of the initial project.

For example, the cores show big gaps in the sediment record from 49 million years

H. von der Fecht

Experts gathered this month at the University of Bremen in Germany to chart the contents of the shafts of rock and mud.

back to around 15 million years ago, Dr. Moran and other participants said, some layers probably removed when either currents or giant ice sheets or icebergs scoured the ridge.

But from 15 million years ago until the present, the sediment layers contain coarse sand and small pebbles that could have reached the ridge top only by riding on raftlike floes of floating ice, implying the presence of a near-constant Arctic ice cap. The layers from those years contain no trace of microscopic plankton that thrive only in sunlight - and thus will appear only if the ocean is free of ice at least part of the year.

Samples from the cores are heading to laboratories around the world for months of additional, detailed analysis of their chemistry, fossil contents and even signatures of past shifts in the earth's magnetic field, which provide a precise clock for dating different layers.

The initial success has already bred half a dozen ambitious new proposals to drill in new places around the basin.

"This is a huge leap forward," said Dr. Martin Jakobsson, a geologist at Stockholm University who worked on the project. "We have shown that we can master the ice."