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Arctic Once Felt Like Florida, Studies Say

By ANDREW C. REVKIN

The first detailed analysis of an extraordinary climatic and biological record from the seabed near the North Pole shows that 55 million years ago the Arctic was much warmer than anyone had thought — a Floridian year-round average of 74 degrees Fahrenheit.

The findings, in three separate papers in the issue of the journal Nature that comes out on Thursday, show how much remains to be learned about climate change, both natural and human-caused. But experts say that if anything, the papers suggest that scientists have greatly underestimated the power of greenhouse gases to warm the planet.

Computer simulations done without the benefit of the seabed sampling do not reproduce an ancient Arctic nearly that warm, the authors said, and thus must be missing elements that lead to greater warming.

"Something extra happens when you push the world into a warmer world, and we just don't understand what it is," said one lead author, Henk Brinkhuis, an expert on ancient Arctic ecology at the University of Utrecht in the Netherlands.

At the same time, he said, the new work reveals no tendency in the polar climate system to turn things around, from warming to cooling. Some scientists have suggested that warming may be a self-limiting process."There is nothing pointing in the other direction," Dr. Brinkhuis said.

The studies draw on the work of a pioneering 2004 expedition that defied the Arctic Ocean ice and pulled the first significant samples from the ancient layered seabed just 150 miles from the North Pole: 1,400 feet of slender shafts of muck, ancient organisms and rock representing a climate history that dates back 56 million years.

While there is ample fossil evidence around the edges of the Arctic Ocean showing great past swings in climate, the ocean itself has been a glaring blank spot in scientists' understanding of climate history. .

The new analysis confirms that the Arctic Ocean warmed to a remarkable degree 55 million years ago and that the warming was driven at least in part by an explosive buildup of heat-trapping greenhouse

gases — one far greater than the current human-caused rise.

The samples also chronicle the subsequent cooling, with many ups and downs, that the researchers say began about 45 million years ago and led to the cycles of ice ages and brief warm spells of the last several million years.

Experts not connected with the studies say they also support the idea that it is greenhouse gases — not slight variations in the Earth's orbit around the Sun — that largely determine the extent of warming or cooling.

"In my opinion, the new research provides additional important evidence that greenhouse-gas changes controlled much of climate history, which strengthens the argument that greenhouse-gas changes are likely to control much of the climate future," said one such expert, Richard B. Alley, a geoscientist at Penn State.

The $12.5 million Arctic Coring Expedition, run by a consortium called the International Ocean Drilling Program, was the first to drill deep into the layers of sediment deposited over millions of years in the ice-cloaked Arctic.

The samples were gathered late in the summer of 2004 as two icebreakers shattered huge drifting floes so a third ship could hold its position and bore into the bottom for nine days.

Estimates of the prevailing temperatures in the different eras represented by the sedimentary layers were made in part by tracking the comings and goings of certain dinoflagellates, a kind of algae that typically indicate subtropical or tropical conditions.

Because the samples lacked remains of shell-bearing plankton that are usually relied on to provide temperature records, the researchers used a newer method for approximating past temperatures: gauging changes in the chemical composition of the remains of a primitive phylum of microbes called Crenarchaeota.

Some scientists familiar with the research said that while there were still questions about the precision of this method at temperatures like those in the ancient Arctic Ocean, over all it was clear that the area was extraordinarily warm.

Another significant discovery came in layers from 49 million years ago, where conditions suddenly fostered the summertime growth of vast mats of an ancient cousin of the Azolla duckweed that now cloaks suburban ponds.

The researchers propose that this occurred when straits closed between the Arctic Ocean and the Pacific and Atlantic Oceans.

The flow of water from precipitation and rivers created a great pool of fresh water, but about 800,000 years after the blossoming of duckweed began, it ended with a sudden warming of a few additional degrees. The researchers suggest that this signaled when shifting land formations reconnected the Arctic with the Atlantic, allowing salty warmer water to flow in, killing off the weed.

The researchers said the sediments held hints that earth's long slide to colder conditions and the recent cycle of ice ages and brief thaws began quite soon after the hothouse days 50 million years ago.

A centerpiece of their argument is a single pebble, about the size of a chickpea, found in a layer created 45 million years ago.

The stone could have been deposited on the raised undersea ridge only if it had been carried overhead in ice, said Kathryn Moran, a chief scientist on the drilling project, who teaches at the University of Rhode Island.

The stone was most likely embedded in an iceberg or perhaps a plate of sea ice that tore free from a gravelly shore. It then sank as the ice melted or broke apart, Dr. Moran proposed. Such "dropstones" have long been used to date when an oceanic region has been ice covered or ice free.

The amount of ice-carried debris in the sediment layers started increasing about 14 million years ago, the scientists said.

That is also about when the great ice sheet that now weighs down eastern Antarctica originated, Dr. Moran noted. In general, the results from the Arctic drilling project suggest that the cooling and ice buildup at both poles happened in relative lock step.

This simultaneity tends to support the idea that the cooling was caused by a drop in concentrations of carbon dioxide and other greenhouse gases, which mix uniformly in the atmosphere around the world, said Dr. Moran and other members of the team.

Julie Brigham-Grette of the University of Massachusetts, an expert in past Arctic climates who was not connected with the new studies, cautioned against putting too much significance in the single sample, and particularly the single stone from 45 million years ago.

She said it was vital to try to mesh the new core results with existing data gathered around Arctic coasts, where there is plenty of evidence for warm conditions in at least some places at some times as recently as 2.4 million years ago.

Despite the questions, she said the project was a stunning achievement.

"It's all very, very exciting to me, because now we can start to rewrite the history of the Arctic," Dr. Brigham-Grette said. "It's like working a giant landscape puzzle of 500 pieces. For a while we only had

100 pieces. Now we have 100 more, and the picture is getting clearer."

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