Algae and pollen grains provide evidence of remarkably warm period in Antarctica's history

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For Sophie Warny, LSU assistant professor of geology and geophysics and curator at the LSU Museum of Natural Science, years of patience in analyzing Antarctic samples with low fossil recovery finally led to a scientific breakthrough. She and colleagues from around the world now have proof of a sudden, remarkably warm period in Antarctica that occurred about 15.7 million years ago and lasted for a few thousand years.

Last year, as Warny was studying samples sent to her from the latest Antarctic Geologic Drilling Program, or ANDRILL AND-2A, a multinational collaboration between the Antarctic Programs of the United States (funded by the National Science Foundation), New Zealand, Italy and Germany, one sample stood out as a complete anomaly.

"First I thought it was a mistake, that it was a sample from another location, not Antarctica, because of the unusual abundance in microscopic fossil cysts of marine algae called dinoflagellates. But it turned out not to be a mistake, it was just an amazingly rich layer," said Warny. "I immediately contacted my U.S. colleague, Rosemary Askin, our New Zealand colleagues, Michael Hannah and Ian Raine, and our German colleague, Barbara Mohr, to let them know about this unique sample as each of our countries had received a third of the ANDRILL samples."

Some colleagues had noted an increase in pollen grains of woody plants in the sample immediately above, but none of the other samples had such a unique abundance in algae, which at first gave Warny some doubts about potential contamination.

"But the two scientists in charge of the drilling, David Harwood of University of Nebraska - Lincoln, and Fabio Florindo of Italy, were equally excited about the discovery," said Warny. "They had noticed that this thin layer had a unique consistency that had been characterized by their team as a diatomite, which is a layer extremely rich in fossils of another algae called diatoms."

All research parties involved met at the Antarctic Research Facility at Florida State University in Tallahassee. Together, they sampled the zone of interest in great detail and processed the new samples in various labs. One month later, the unusual abundance in microfossils was confirmed.

Among the 1,107 meters of sediments recovered and analyzed for microfossil content, a two-meter thick layer in the core displayed extremely rich fossil content. This is unusual because the Antarctic ice sheet was formed about 35 million years ago, and the frigid temperatures there impede the presence of woody plants and blooms of dinoflagellate algae.

"We all analyzed the new samples and saw a 2,000 fold increase in two species of fossil dinoflagellate cysts, a five-fold increase in freshwater algae and up to an 80-fold increase in terrestrial pollen," said Warny. "Together, these shifts in the microfossil assemblages represent a relatively short period of time during which Antarctica became abruptly much warmer."

These palynomorphs, a term used to described dust-size organic material such as pollen, spores and cysts of dinoflagellates and other algae,

provide hard evidence that Antarctica underwent a brief but rapid period of warming about 15 million years before present.

"This event will lead to a better understanding of global connections and climate forcing, in other words, it will provide a better understanding of how external factors imposed fluctuations in Earth's climate system," said Harwood. "The Mid-Miocene Climate Optimum has long been recognized in global proxy records outside of the Antarctic region. Direct information from a setting proximal to the dynamic Antarctic ice sheets responsible for driving many of these changes is vital to the correct calibration and interpretation of these proxy records."

These startling results will offer new insight into Antarctica's climatic past - insights that could potentially help climate scientists better understand the current climate change scenario.

"In the case of these results, the microfossils provide us with quantitative data of what the environment was actually like in Antarctica at the time, showing how this continent reacted when climatic conditions were warmer than they are today," said Warny.

According to the researchers, these fossils show that land temperatures reached a January average of 10 degrees Celsius - the equivalent of approximately 50 degrees Fahrenheit - and that estimated sea surface temperatures ranged between zero and 11.5 degrees Celsius. The presence of freshwater algae in the sediments suggests to researchers that an increase in meltwater and perhaps also in rainfall produced ponds and lakes adjacent to the Ross Sea during this warm period, which would obviously have resulted in some reduction in sea ice.

These findings most likely reflect a poleward shift of the jet stream in the Southern Hemisphere, which would have pushed warmer water toward the pole and allowed a few dinoflagellate species to flourish

under such ice-free conditions. Researchers believe that shrub-like woody plants might also have been able to proliferate during an abrupt and brief warmer time interval.

"An understanding of this event, in the context of timing and magnitude of the change, has important implications for how the climate system operates and what the potential future response in a warmer global climate might be," said Harwood. "A clear understanding of what has happened in the past, and the integration of these data into ice sheet and climate models, are important steps in advancing the ability of these computer models to reproduce past conditions, and with improved models be able to better predict future climate responses."

While the results are certainly impressive, the work isn't yet complete.

"The SMS Project Science Team is currently looking at the stratigraphic sequence and timing of climate events evident throughout the ANDRILL AND-2A drillcore, including those that enclose this event," said Florindo. "A broader understanding of ice sheet behavior under warmer-than-present conditions will emerge."

Source: Louisiana State University (news : web)