Study breaks ice on ancient arctic thaw

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A new analysis of ocean-floor sediments collected near the North Pole finds that the Arctic was extremely warm, unusually wet and ice-free the last time massive amounts of greenhouse gases were released into the Earth's atmosphere - a prehistoric period 55 million years ago. The findings appear in the Aug. 10 issue of *Nature*.

Current climatic evidence and computer models suggest the modern Arctic is rapidly warming, gaining precipitation and becoming ice-free because of carbon emissions. Scientists have been keen to unlock the mysteries of the Arctic when this last happened - an interval known as the Paleocene/Eocene thermal maximum, or PETM. Researchers have long known that a massive release of greenhouse gases, probably carbon dioxide or methane, occurred during the PETM. Surface temperatures also rose in many places by as much as 15 degrees Fahrenheit in the relative geological instant of about 100,000 years.

Past analyses of seafloor sediments and sedimentary rocks worldwide have given scientists many clues about the PETM, but sediments from the Arctic remained elusive until 2004, when the $12.5 million Arctic Coring Expedition (ACEX) recovered the first deep sediments from beneath the ice near the North Pole.

"Building a picture of ancient climatic events is a lot like putting together a jigsaw puzzle, and what ACEX allowed us to do was fill in a blank section of the PETM picture," said Gerald Dickens, a Rice University geochemist and study co-author who conducted the initial, shipboard chemical analyses of all the ACEX core samples.

"The ACEX cores clearly show that the Arctic got very warm and wet during the PETM," Dickens said. "Even tropical marine plants thrived in the balmy conditions."

Certain species of microscopic plants in today's oceans are known to rapidly multiply and create algal blooms, including "red tides," under certain conditions. Dickens said that fossils of these plants - known only from the tropics before the PETM - suddenly become common in the ACEX cores.

Furthermore, the chemistry of the organic carbon in the ACEX cores may rule out some earlier theories about what caused the PETM. The diminution of these alternate explanations strongly suggests that an enormous amount of carbon entered the atmosphere at the beginning of the PETM, either from volcanic eruptions or the melting of oceanic gas hydrates - mixtures of methane and ice on the seafloor.

In previous research, Dickens and colleagues have estimated that the amount of methane carbon trapped in ocean gas hydrates worldwide likely exceeds all the carbon in all the world's oil, coal and natural gas reserves combined. Given the magnitude of carbon trapped in oceanic gas hydrates, and the fact that hydrates are susceptible to melting when adjacent seawater warms by as little as 3-4 degrees Fahrenheit, Dickens said it is probable that at least some of the PETM greenhouse gases came from methane that bubbled up from the seafloor.

"The magnitude of the carbon input at the PETM outset is truly enormous," Dickens said. "If it were all volcanic, you'd need something like a Vesuvius-sized eruption each day for centuries, which seems very unlikely."

Dickens said the ACEX cores, which have already resulted in three previous Nature papers, will likely produce even more groundbreaking

results.

"It's difficult to overestimate the importance of this kind of experimental evidence," he said. "It's like opening a door to a room you've seen on a blueprint but never stepped foot inside."

Co-authors on the paper include Mark Pagani and Nikolai Pedentchouk of Yale University, Matthew Huber of Purdue University, Appy Sluijs and Henk Brinkhuis of Utrecht University, and Stefan Schouten and Jaap Sinninghe Damsté of the Royal Netherlands Institute for Sea Research.

Source: Rice University