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Ancient "Snowball Earth" Melted Fast Due to Methane

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A massive release of methane, a potent greenhouse gas, may have triggered rapid melting of the last "snowball Earth" about 635 million years ago, a new study suggests.

According to the snowball theory, ancient Earth experienced periods of global glaciation when ice sheets extended all the way to the Equator.

Methane ice forms and stabilizes beneath glaciers under certain temperatures and pressures, noted lead study author Martin Kennedy, a geologist at the University of California, Riverside.

But ice sheets are inherently unstable. Once they reach a certain size, they begin to fall apart.

The collapse of ancient ice sheets at the Equator would have unleashed trapped methane deposits and pushed global temperatures higher.

This warming would have caused ice sheets at slightly higher latitudes to melt, unleashing even more methane and causing Earth to warm even more.

"You can see the feedback there, that pretty soon you'll unzipper the entire reservoir" of methane, Kennedy said, which could have caused the abrupt transition from a very cold state to a much warmer climate.

A similar mechanism, the authors say, could uncontrollably accelerate global warming today.

Warming Trigger

Kennedy and colleagues collected and analyzed hundreds of marine sediment samples from a region of South Australia state that was near the Equator about 635 million years ago.

They found a broad range of chemical signatures in the sediments consistent with melting ice sheets and destabilization of methane deposits.

In addition, they found evidence that ice-sheet collapse and methane release preceded a rise in global sea levels.

"The coincidence of being able to find all these particular lines of evidence tells us that we might have found the trigger for deglaciation," Kennedy said.

The researchers describe their work in tomorrow's issue of the journal Nature.

Richard Norris is a paleobiologist at the Scripps Institution of Oceanography at the University of California, San Diego, who was not involved in the study.

He said Kennedy's team has solid evidence and makes a reasonable case for a methane-driven warming event.

"I don't think it is proof, but it is what you'd expect to find if it is true," he said.

According to Kennedy, a similar abrupt temperature spike could occur today if abundant methane deposits in the Arctic permafrost and the continental margins of the oceans are suddenly released.

(Related: "Deep Sea, Arctic, May Hold World's Largest Fuel Supply, Experts Say" [March 7, 2007].)

"We're sitting at a time when we're forcing the climate enormously, and we're wondering what the relevant analog for our future climate is going to be," he added.

"I would suggest that this particular type of feedback is one scenario that we could be looking at in the future."

Warning Sign?

Norris, of the Scripps Institution, agrees that today's methane reservoirs are enormous and warrant keeping a close eye on as the climate changes.

"They could be a real problem for us," he said.

But he cautioned that the connection between snowball Earth and modern warming is tenuous, because the world is dramatically different now than it was millions of years ago.

For example, Earth is far from a snowball state, and the continents are in different positions and thus have different effects on ocean and atmospheric circulation.

Also, it's unknown how fast the transition from snowball Earth to a warmer world occurred, Norris said.

If methane was released over hundreds or thousands of years, the associated climate changes could have been catastrophic.

But over longer time scales, Earth processes could have absorbed the excess carbon, lessening the impact.

While they remain unsure about the exact duration of the ancient event, Kennedy and other researchers believe the evidence is consistent with changes over geologically short time scales.

A more critical issue is to figure out how much warming is required to trigger the release of methane deposits, Kennedy said.

"This scenario is one that once triggered, there is nothing to stop it," he said. "You have to act preemptively before the trigger is reached."