World's oldest rocks show how Earth may have dodged frozen fate of Mars

February 5 2007

Doctoral student Nicole Cates and Assistant Professor Stephen Mojzsis survey a landscape of ancient rocks in Hudson Bay, Quebec, in Canada confirmed by the CU-Boulder team to date back roughly 3.75 billion years, making them among the most oldest known rocks on Earth. Image courtesy CU-Boulder

Carbon dioxide, a greenhouse gas that has become a bane of modern society, may have saved Earth from freezing over early in the planet's history, according to the first detailed laboratory analysis of the world's oldest sedimentary rocks.

Scientists have theorized for years that high concentrations of greenhouse gases could have helped Earth avoid global freezing in its youth by allowing the atmosphere to retain more heat than it lost. Now a

team from the University of Chicago and the University of Colorado at Boulder that analyzed ancient rocks from the eastern shore of Hudson Bay in northern Quebec, Canada, have discovered the first direct field evidence supporting this theory.

The study shows carbon dioxide in Earth's atmosphere could have sustained surface temperatures above freezing before 3.75 billion years ago according to the researchers, led by University of Chicago Assistant Professor Nicolas Dauphas. Co-authors on the study, which appeared online Jan. 16 in the journal Earth and Planetary Science Letters, included Assistant Professor Stephen Mojzsis and doctoral student Nicole Cates of CU-Boulder's geological sciences department and Vincent Busigny, now of the Institut de Physique du Globe in Paris.

The new study helps explain how Earth may have avoided becoming frozen solid early in its history, when astrophysicists believe the sun was 25 percent fainter than today. Previous studies had shown liquid water existed at Earth's surface even though the weak sun should have been unable to warm the planet above freezing conditions. But high concentrations of CO_2 or methane could have warmed the planet, according to the research team.

The ancient rocks from Quebec contain iron carbonates believed to have precipitated from ancient oceans, according to the study. Since the iron carbonates could only have formed in an atmosphere containing far higher CO_2 levels than those found in Earth's atmosphere today, the researchers concluded the early Earth environment was extremely rich in CO_2.

"We now have direct evidence that Earth's atmosphere was loaded with CO_2 early in its history, which probably kept the planet from freezing and going the way of Mars," said Mojzsis.

The CO2 could even have played a role as a "planetary thermostat," since cold, icy conditions on Earth would have decreased the chemical weathering of rocks and increased the amount of CO_2 moving into the atmosphere, ratcheting up Earth's surface temperatures, according to Dauphas.

In a companion article that appeared online Feb. 2 in *Earth and Planetary Science Letters*, Mojzsis, Cates and CU-Boulder undergraduate Jon Adam used a technique known as uranium-lead dating to establish the ancient age of the Hudson Bay rocks. Discovered by Canadian scientists in 2001, the rocks were confirmed by Mojzsis and his team to be at least as old as an isolated outcropping of West Greenland rocks previously believed by researchers to be the oldest on Earth.

The CU-Boulder team analyzed the rocks by crushing them into powder and dating zircon crystals present in the rock, said Mojzsis. The technique allowed them to calculate the geologic age of the crystals based on the radioactive decay rate of the uranium and lead isotopes in relation to each other, a technique known to be accurate to 1 percent or less.

"Zircon is nature's best timekeeper," said Mojzsis. "The tests show that the rocks in Quebec are roughly 3.75 billion years old, about the same as the West Greenland rocks."

The landscape of the Hudson Bay region under study today, marked by hills of grassland and marsh peppered by lakes, streams and craggy outcroppings, is much different from the alien Earth of 3.8 billion years ago, said Mojzsis. In much earlier times, a dense atmosphere of CO_2 would have given the sky a reddish cast, and a greenish-blue ocean of iron-rich water would have lapped onto beaches, he said.

While scientists have been concerned that the limited sample of Earth's

oldest known rocks from West Greenland provided a biased view of early Earth, the Hudson Bay discovery essentially doubles the known amount of extremely ancient rocks, and there appear to be a number of similar, ancient outcrops in the vicinity. "We are now finding Earth's oldest rocks are not as rare as we once thought," Mojzsis said.

Source: University of Colorado at Boulder