New Method of Studying Ancient Fossils Points to Carbon Dioxide As a Driver of Global Warming

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A team of American and Canadian scientists has devised a new way to study Earth's past climate by analyzing the chemical composition of ancient marine fossils. The first published tests with the method further support the view that atmospheric CO2 has contributed to dramatic climate variations in the past, and strengthen projections that human CO2 emissions could cause global warming.

In the current issue of the journal *Nature*, geologists and environmental scientists from the California Institute of Technology, the University of Ottawa, the Memorial University of Newfoundland, Brock University, and the Waquoit Bay National Estuarine Research Reserve report the results of a new method for determining the growth temperatures of carbonate fossils such as shells and corals. This method looks at the percentage of rare isotopes of oxygen and carbon that bond with each other rather than being randomly distributed through their mineral lattices.

Because these bonds between oxygen-18 and carbon-13 form in greater abundance at low temperatures and lesser abundance at higher temperatures, a precise measurement of their concentration in a carbonate fossil can quantify the temperature of seawater in which the organisms lived. By comparing this record of temperature change with previous estimates of past atmospheric CO2 concentrations, the study demonstrates a strong coupling of atmospheric temperatures and carbon dioxide concentrations across one of Earth's major environmental shifts.

According to Rosemarie Came, a postdoctoral scholar in geochemistry at Caltech and lead author of the article, only about 60 parts per million of the carbonate molecular groups that make up the mineral structures of carbonate fossils are a combination of both oxygen-18 and carbon-13, but the amount varies predictably with temperature. Therefore, knowing the age of the sample and how much of these exotic carbonate groups are present allows one to create a record of the planet's temperature through time.

"This clumped-isotope method has an advantage over previous approaches because we're looking at the distribution of rare isotopes inside a single shell or coral," Came says. "All the information needed to study the surface temperature at the time the animal lived is stored in the fossil itself."

In this way, the method contrasts with previous approaches that require knowledge of the chemistry of seawater in the distant past--something that is poorly known.

The study contrasts the growth temperatures of fossils from two times in the distant geological past. The Silurian period, approximately 400 million years ago, is thought to have been a time of highly elevated atmospheric CO2 (more than 10 times the modern concentration), and was found by the researchers to be a time of exceptionally warm shallow-ocean temperatures--nearly 35 degrees C. In contrast, the Carboniferous period, roughly 300 million years ago, appears to have been characterized by far lower levels of atmospheric carbon dioxide (similar to modern values) and had shallow marine temperatures similar to or slightly cooler than today-about 25 degrees C. Thus, the draw-down of atmospheric CO2 coincided with strong global cooling.

"This is a huge change in temperature," says John Eiler, a professor of geochemistry at Caltech and a coauthor of the study. "It shows that carbon dioxide really has been a powerful driver of climate change in Earth's past."

The title of the *Nature* paper is "Coupling of surface temperatures and atmospheric CO2 concentrations during the Paleozoic era." The other authors are Jan Veizer of the University of Ottawa, Karem Azmy of Memorial University of Newfoundland, Uwe Brand of Brock University, and Christopher R. Weidman of the Waquoit National Estuarine Research Reserve, Massachusetts.

Source: Caltech

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