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FOSSIL RECORD SHOWS TROPICAL PACIFIC LEADS CLIMATE CHANGE; IMPLICATIONS FOR GLOBAL WARMING

The Pacific Ocean leads, is how paleoclimatologist and first author David W. Lea

summarizes the climatological discoveries featured in this week's Science Magazine.

"The poetry of it is that a little one-celled creature -- the size of an ameoba -- enables us to read the history of past climate change," said Lea, associate professor of geological sciences at the University of California, Santa Barbara.

The subtext is this, "If we can understand the mechanism of climate change then we can see how global warming will play out," said Lea.

Just like El Nino and La Nina cause short term world-wide climate changes emanating from the waters of the Pacific warm pool, it appears that the tropical Pacific may be the driver of the changes that have lead to past ice ages, according to the researchers (who besides Lea include Dorothy K. Pak, a researcher at UC Santa Barbara and Howard J. Spero, who did his graduate work at UC Santa Barbara and is now at UC Davis.)

In this paper, Climate Impact of the Late Quaternary Equatorial Pacific Sea Surface Temperature Variations, the authors make the case for the importance of the tropical Pacific, rather than the North Atlantic, as a key region for the transmission of global climate climate change.

Although climatologists largely agree upon the Milankovitch theory of climate change (which holds that the changing distribution of radiation from the sun over time is responsible for climate change) the question has always remained as to what exactly causes the climate to flip between interglacial and glacial periods.

Lea explained that the favorite theory had always been that a combination of high latitude and North Atlantic processes were the drivers.

And yet, for at least eight years, leaders in the field have been considering that the tropics might have a greater role.

"The problem," said Lea, "was that there has been a dearth of unambiguous data showing that the tropics were involved in global scale climate change."

Enter the tiny sea creature, planktonic foraminifera, which have lived in the oceans for millions of years, with critical clues to the history of global climate change. (See photo and sidebar.)

In a unique interdisciplinary team effort, David Lea worked with Howard J. Spero, who is trained in both biology and geology, to grow the tiny one-celled organisms in the lab, and together with several other research teams developed a new way to reconstruct temperatures in the past, the study of "paleotemperature."

They discovered that the "foram" shells differed in their magnesium content depending upon the temperature of the water, and thus the shells became a powerful tool for looking back into the history of climate change.

Another chemical recorder used in the study is analysis of oxygen isotopes, which records the extent of continental ice sheets.

The authors picked two spots in the equatorial Pacific, one in the East near the Galapagos and one in the West, Northeast of New Guinea, allowing them to assess both the cold and warm side of the Pacific.

They looked at cores of mud taken from the floor of the Pacific and analyzed, among other things, the chemical composition of the tiny fossilized foraminifera. The tiny shells are found in sedimentary layers of mud that read back through time like the rings of a tree. The chemical results indicate that the tropical Pacific, the oceanic region most isolated from continental ice sheets, cooled by at least 3 degrees Celcius during each of the last 5 ice ages.

"The data indicates that when you look at temperature changes in the Pacific Ocean, they occur before the change in the ice sheets." said Lea.

"The tropical oceans might therefore be a major driving force in the waxing and waning of continental ice sheets."

"If ocean temperature changes before the ice sheets," he continued, "then the natural hypothesis is that the Earth's orbital variation promotes changes in the tropical Pacific that are transmitted through atmospheric and oceanic processes to other parts of the Earth.

This is possible because the tropical oceans act as a global heat engine."

The results are the product of two years of lab work, with a team of researchers sifting through the ocean mud cores and analyzing the foraminifera fossils.

Editors: Photographs of planktonic foraminifera are available by e-mail.

For more information on David Lea's research see his website at:
http://www.geol.ucsb.edu/faculty/lea/

TINY OCEAN CRITTER TELLS CLIMATE STORY

In an amazing fact of science, small ocean-dwelling creatures tell the history of the Earth's climate.

Paleoceanographer David Lea, of the University of California, Santa Barbara, and his team have spent years researching several species of a tiny floating marine organism, planktonic foraminifera, which happen to yield not only secrets of the ocean, but of global climate history as well, as explained in this week's Science Magazine article.

According to Briant T. Huber of the National Museum of Natural History which houses the world's largest collection, "foraminifera are tiny single-celled organisms that construct shells. They inhabit a wide range of marine environments, from the intertidal zone to the deep sea in all regions..

"The shells occur in a variety of shapes, and typically range from .1 mm to 1 mm in size. The shells of all planktic (floating) and most benthic (deep ocean) species are composed of calcite, the same mineral larger sea shells are made of...Planktic species range to about 190 million years. The abundance of their shells in ancient sediments, their wide distribution and their sensitivity to changes in environmental conditions make them valuable indicators of past climate change."

Researchers in the Lea lab grew the foraminifera in a variety of temperatures to discover that they vary in the amount of magnesium in their shells as a function of water temperature.

And they spent two years sifting through the mud of deep ocean cores taken in the Pacific, ferreting out the ancient foraminifera shells and analyzing their magnesium content, among other factors, to construct a historical record of ocean temperature, going back in time 450,000 years, and including four to five ice ages.

It seemed that the mud was just waiting for the right scientific and historical moment to yield its clues. One of the cores, taken by UC Santa Barbara paleoceanographer James Kennett 25 years ago, had been gathering dust in the basement of the Webb Hall, in the Department of Geological Sciences, for the past 15 years.

Editors: See main story, FOSSIL RECORD SHOWS PACIFIC OCEAN LEADS CLIMATE CHANGE; IMPLICATIONS FOR GLOBAL WARMING

Graphics are available by e-mail.

About UC Santa Barbara

All of this takes place within a living and learning environment like no other, as we draw inspiration from the beauty and resources of our extraordinary location at the edge of the Pacific Ocean.