Cave study links climate change to California droughts

November 10 2009

California experienced centuries-long droughts in the past 20,000 years that coincided with the thawing of ice caps in the Arctic, according to a new study by UC Davis doctoral student Jessica Oster and geology professor Isabel Montañez.

The finding, which comes from analyzing stalagmites from Moaning Cavern in the central Sierra Nevada, was published online Nov. 5 in the journal *Earth and Planetary Science Letters*.

The sometimes spectacular mineral formations in caves such as Moaning Cavern and Black Chasm build up over centuries as water drips from the cave roof. Those drops of water pick up trace chemicals in their path through air, soil and rocks, and deposit the chemicals in the stalagmite.

"They're like tree rings made out of rock," Montañez said. "These are the only climate records of this type for California for this period when past global warming was occurring."

At the end of the last ice age about 15,000 years ago, climate records from Greenland show a warm period called the Bolling-Allerod period. Oster and Montanez's results show that at the same time, California became much drier. Episodes of relative cooling in the Arctic records, including the Younger Dryas period 13,000 years ago, were accompanied by wetter periods in California.

The researchers don't know exactly what connects Arctic temperatures to

precipitation over California. However, climate models developed by others suggest that when Arctic sea ice disappears, the jet stream -- high-altitude winds with a profound influence on climate -- shifts north, moving precipitation away from California.

"If there is a connection to Arctic sea ice then there are big implications for us in California," Montañez said. Arctic sea ice has declined by about 3 percent a year over the past three decades, and some forecasts predict an ice-free Arctic ocean as soon as 2020.

Oster's analysis of the past is rooted in a thorough understanding of the cave in the present. Working with the cave owners, she has measured drip rates, collected air, water, soil and vegetation samples, and studied what happens to the cave through wet and dry seasons to determine how stalagmites are affected by changing conditions.

Oster collected stalagmites and cut tiny samples from them for analysis. The ratio of uranium to its breakdown product, thorium, allowed her to date the layers within the stalagmite. Isotopes of oxygen, carbon and strontium and levels of metals in the cave minerals all vary as the climate gets wetter or drier.

"Most respond to precipitation in some way," Oster said. For example, carbon isotopes reflect the amount of vegetation on the ground over the cave. Other minerals tend to decrease when rainfall is high and water moves through the aquifer more rapidly.

Oxygen-18 isotopes vary with both temperature and rainfall. Measuring the other mineral compositions provides more certainty that the changes primarily track relative rainfall.

The stalagmite records allowed Oster and Montañez to follow relative changes in precipitation in the western Sierra Nevada with a resolution

of less than a century.

"We can't quantify precipitation, but we can see a relative shift from wetter to drier conditions with each episode of warming in the northern polar region," Montañez said.

Source: University of California - Davis