Fossil Leaves Depict Warm, High Sierra Nevada Mountains in Ancient Past

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Geologists used fossil leaves to reconstruct the ancient climate of the Sierra Nevada mountain range in California. (Photo: Michael Hren)

(PhysOrg.com) -- A team led by Yale University geologists has reconstructed the climate and elevation of California's northern Sierra Nevada mountains using organic materials derived from ancient leaves and bacteria.

Their findings, published in the January issue of the journal *Geology*, show that the Sierra Nevada was warmer in the past and was a prominent topographic feature at least 50 million years ago, helping to resolve long-standing questions regarding the tectonic history of the mountain range.

Until now, many scientists believed the prominence of the Sierra Nevada developed more recently, with rapid "uplift" over the past 20 million

years. In this new study, the team has shown the mountain range was in fact just as tall as far back as 50 million years ago as it is today. They also discovered the region was 6-8 degrees Celsius warmer than today, consistent with other evidence for a globally warmer, ice-free Earth at that time.

The researchers analyzed the hydrogen isotope composition of waxes from ancient leaves preserved in river sediments from the early Eocene epoch, which in turn informed them of the isotope composition of the precipitation. Because the isotope composition of rain changes as clouds pass over a mountain range and drop precipitation, the team could then infer the height of the mountains at that time. They also used temperature-sensitive bacterial compounds in soils to determine how surface temperatures changed with elevation.

“Because Earth’s climate has changed over geologic time, it can be difficult to distinguish between local temperature change related to the formation of mountains and past climate,” said first author Michael Hren, who conducted the research while a postdoctoral fellow at Yale and is now at the University of Michigan. “By bringing together two independent records of the ancient environment, we’re able to provide new interpretations of the height of the ancient mountains and how different the regional climate was from today during this time of extreme warming.”

Fifty million years ago, atmospheric carbon dioxide (CO_2) levels were more than four times as high as today, so uncovering this past climate has important implications for understanding today’s rising CO_2 levels.

“We need to go back to periods of high CO_2 and high temperature and try to understand climate on a broad scale,” Hren said. “We have a number of models capable of predicting future climate change, but if we really want to test some of these it’s useful to go back to the ancient

environment and see what it looked like during these extreme periods."

Other authors of the paper include Mark Pagani and Mark Brandon (Yale University) and Diane Erwin (Berkeley Museum of Paleontology).

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