Researcher finds key to ancient weather patterns in Florida's caves

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(PhysOrg.com) -- Darrel Tremaine has been known to go to extremes for his research, such as crawling on his hands and knees through a dark, muddy limestone cave in Northwest Florida to learn more about the weather thousands of years ago.

His goal? To compare ancient meteorological patterns with modern ones in the northern Gulf of Mexico region and ultimately inform policymakers on how to build a sustainable water supply.

On a recent morning, the Florida State University doctoral student in oceanography huddled with artisan Charlie Scott-Smith at Florida State's Master Craftsman Studios. The two were making molds of stalagmites, the natural formations rising from the floor of limestone caves that are formed by the dripping of water containing calcium carbonate. (Their

counterparts, stalactites, hang from the ceilings of such caves.)

Surrounded by the studio's eye-catching artifacts — models of architectural fittings, an ancient ship, even a copy of the sculpture "Winged Victory" from the Louvre Museum — Tremaine and Scott-Smith worked with a rubbery urethane compound to create stalagmite molds that resembled giant beeswax candles. Next, they filled the molds with cement and glass.

After the cement thoroughly dried, Tremaine returned the reproduction stalagmites to the cave, where, over time, dripping water will coat them with calcite and they will start growing again. The remote, Northwest Florida cave maintains a constant, year-round temperature of 72 degrees and a 100 percent relative humidity level, which means, as Tremaine likes to joke, "that if you start to sweat, you stay wet."

As part of a three-year climate research project, he harvested the two stalagmites — one 4,000 years old, the other 25,000 years old — from the cave to analyze them for isotopic and trace element variations in an effort to build a 4,000-year paleo-rainfall record for North Florida. In a unique arrangement with the Southeastern Cave Conservancy Inc. (SCCI), a nonprofit group that owns dozens of caves in the southeastern United States, he was allowed to take the stalagmites as long as he made duplicates of them and placed the duplicates back in the cave — a measure of cave conservation.

The real stalagmites will be studied at the National High Magnetic Field Laboratory at Florida State, where Tremaine, a graduate research assistant, is currently stationed in the geochemistry lab.

So far, Tremaine has been scrutinizing carbon, oxygen and strontium isotopes on modern calcite grown in the cave on glass microscope slides

— what he calls "modern calibrations of ancient proxies." Isotopes of an element are atoms with the same number of protons but different number of neutrons, thus a slightly different atomic mass. He will use that data to get a better idea of ancient ventilation patterns, the temperature inside of a cave when the stalagmites were forming, what type of vegetation was growing above the cave, of, and whether the weather was cold, warm or hot during a particular span of time.

"By looking at trace elements we can get an idea of very wet and very dry rainfall patterns and cycles," Tremaine said. "We'll better understand severe weather patterns."

Tremaine, along with a six-member team of scientists, researchers and graduate students, will cut the stalagmites in half and then use a 50-micron laser to vaporize calcite that they will then measure with a spectrometer. The laser will allow them to study monthly weather patterns in the Northern Gulf Region thousands of years ago. By extracting calcite powders with a half-millimeter drill bit, they will examine the region's wet and dry seasons in five-year increments. Eventually, they hope to create a high-resolution time series, analyzing monthly weather patterns over thousands of years.

"We will be the first to do this in the southeastern United States," he explained. "The research is very important because we will be able to study our monsoonal weather patterns, which are much like India and China, with very wet and dry seasons. "

Tremaine's six-member climate research team includes a wide swath of experts, from a retired professor to a Russian mathematician and an undergraduate cave researcher. They are Florida State faculty members Philip "Flip" Froelich, retired FSU Francis Eppes Professor of Oceanography; Bill Burnett, the Carl Henry Oppenheimer Professor of Oceanography; and Doron Nof, Distinguished Nansen Professor of

Physical Oceanography. In addition, Guy "Harley" Means, assistant state geologist at the Florida Geological Survey; Brian Kilgore, a Florida State undergraduate majoring in biochemistry; and Karina Khazmutdinova, a mathematician and doctoral student at the FSU Geophysical Fluid Dynamics Institute, served on the team.

Their research work on isotopes was recently published in the journal *Geochimica et Cosmochimica Acta*. Tremaine and his team's research on trace elements also will soon be published in the same research journal. They are also in the process of writing an article for the Journal of Hydrology.

"Records of past climates can be found in the ice caps and in the deep sea," said Jeff Chanton, FSU's John W. Winchester Professor of Oceanography, who has worked with Tremaine. "The unique aspect of Darrel's work is that it will give us a record of local climate right here on the Northern Gulf Coast. This is important because a record of past climate in our region would help to predict what's to come in response to human disturbances of atmospheric greenhouse gas concentrations."

The 32-year-old Tremaine, who holds a master's degree in oceanography from Florida State and an undergraduate degree in engineering from the University of Cincinnati, dreams of someday starting his own groundwater research lab, where he would also teach middle and high school students to do research.

"Working with younger kids and teaching them to do research early makes sense, because if we inform them, they will someday inform us," he said.

But first, Tremaine and his team recently negotiated permission from the state of Florida to move their cave-monitoring equipment into one of the most pristine and highly guarded caves in Florida Caverns State Park,

located near the Panhandle town of Marianna. Tremaine has already been in the cave for preliminary investigations, and the team began installing equipment in November.

Not easy work, by any means: "No one," Tremaine explained one morning while he helped Florida State Master Craftsman artisans put the final touches on the stalagmite molds, "has been in that cave since 2006."

Provided by Florida State University