PRL group deciphers climate variations recorded in stalagmite

The data reveal 70–100-year-long mega drought events

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Analysing bits of a stalagmite from Kotumsar cave in Central India, a collaboration involving researchers from Physical Research Laboratory (PRL), Ahmedabad, has revealed variations of the Indian summer monsoon over some 3,000 years, starting from 8,500 years ago to 5,600 years ago. The data shows fine resolution, allowing observers to interpret sub-annual to sub-decadal variations in the monsoon, which can be used to understand climate, as well as to understand societal changes that took place in South Asia. The article is published in the journal Quaternary International.

Ancient rock

The Kotumsar cave is 35 metres below ground level and located in the Kanger Valley National Park of Chhattisgarh. It formed by slow dissolution of the Kanger limestone by water from the Indian summer monsoon (June to September) over hundreds of thousands of years. The team recovered the stalagmite rock sample with great difficulty. “When our team entered the Kotumsar cave, we had to crawl in a very suffocating and highly humid environment to look for a suitable sample,” says Madhusudan G. Yadava, scientist with the Geoscience Division, PRL.

Of particular interest in understanding climate is the mid-Holocene, a period nearly 7,000 years back, during which rapid and significant changes took place that are supposed to have affected the cultural practices of early humans, such as agriculture.

Instrument-based records of climate do not go beyond a few hundred years, whereas to study paleoclimate, we need data that span thousands of years. The piecing together of paleoclimate is done using indirect records such as tree rings. One such record is held by the so-called speleothems - rocks that were formed in caves over several years by the deposition of water from monsoon. Just like tree rings, these also hold records of seasonal variations.

Mega droughts

The team used Uranium-Thorium dating to study the sample, for which the sample had to be sent to National Taiwan University in Taipei. “It took more than a year to get results from Taiwan,” says Dr. Yadava. The U-Th dating requires careful handling under clean lab environment and also takes a lot of time. “Initially, we tried the radiocarbon dating method in PRL itself. It showed inconsistent results, indicating that the radiocarbon method is not suitable for this sample,” adds Dr. Yadava.

The main answers the team sought were whether there were abrupt changes in the monsoon in the past, and, if so, what were the possible causative factors. The team found that at the beginning of the mid-Holocene, from 8,500 years ago to 6,500 years ago, the monsoon had started declining. The team also noticed 70-100-year-long mega drought events. They also noticed that, gradually, the summer monsoon increased between 6,500 years ago to 5,600 years ago.

They also find a correlation between the variations in the Indian summer monsoon during the mid-Holocene and the El-Nino Southern Oscillation. Shraddha T Band, first author of the paper, who is now a post-doctoral fellow in Academia Sinica in Taiwan, asserts how reconstruction of the paleomonsoon helped them understand various climate parameters modulating the monsoon dynamics at different timescales.

“Such studies at higher resolution may assist climate modellers in predictions of temperature and rainfall...” Further speleothem analysis from the core monsoon zone of India may help link the Indian summer monsoon with the climate variability in the North Atlantic,” she adds.