

Scientists discover evidence for past high-level sea rise

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A closeup of the bulbous stalactitic feature of a phreatic overgrowth on speleothems (POS). Credit: University of New Mexico

An international team of scientists, studying evidence preserved in speleothems in a coastal cave, illustrate that more than three million years ago—a time in which the Earth was two to three degrees Celsius warmer than the pre-industrial era—sea level was as much as 16 meters higher than the present day. Their findings represent significant

implications for understanding and predicting the pace of current-day sea level rise amid a warming climate.

The scientists, including Professor Yemane Asmerom and Sr. Research Scientist Victor Polyak from The University of New Mexico, the University of South Florida, Universitat de les Illes Balears and Columbia University, published their findings in today's edition of the journal *Nature*. The analysis of deposits from Artà Cave on the island of Mallorca in the western Mediterranean Sea produced sea levels that serve as a target for future studies of ice sheet stability, ice sheet model calibrations and projections of future [sea level](#) rise, the scientists said.

Sea level rises as a result of melting ice sheets, such as those that cover Greenland and Antarctica. However, how much and how fast sea level will rise during warming is a question scientists have worked to answer. Reconstructing ice sheet and sea-level changes during past periods when climate was naturally warmer than today, provides an Earth's scale laboratory experiment to study this question according to USF Ph.D. student Oana Dumitru, the lead author, who did much of her dating work at UNM under the guidance of Asmerom and Polyak.

"Constraining models for sea level rise due to increased warming critically depends on actual measurements of past sea level," said Polyak. "This study provides very robust measurements of sea level heights during the Pliocene."

"We can use knowledge gained from past warm periods to tune ice sheet models that are then used to predict future [ice sheet](#) response to current global warming," said USF Department of Geosciences Professor Bogdan Onac.

The project focused on cave deposits known as phreatic overgrowths on speleothems. The deposits form in coastal caves at the interface between

brackish water and cave air each time the ancient caves were flooded by rising sea levels. In Artà Cave, which is located within 100 meters of the coast, the water table is—and was in the past—coincident with sea level, says Professor Joan J. Fornós of Universitat de les Illes Balears.

The scientists discovered, analyzed, and interpreted six of the geologic formations found at elevations of 22.5 to 32 meters above present sea level. Careful sampling and laboratory analyses of 70 samples resulted in ages ranging from 4.4 to 3.3 million years old BP (Before Present), indicating that the cave deposits formed during the Pliocene epoch. The ages were determined using uranium-lead radiometric dating in UNM's Radiogenic Isotope Laboratory.

"This was a unique convergence between an ideally-suited natural setting worked out by the team of [cave](#) scientists and the technical developments we have achieved over the years in our lab at The University of New Mexico," said Asmerom. "Judicious investments in instrumentation and techniques result in these kinds of high-impact dividends."

"Sea level changes at Artà Cave can be caused by the melting and growing of ice sheets or by uplift or subsidence of the island itself," said Columbia University Assistant Professor Jacky Austermann, a member of the research team. She used numerical and statistical models to carefully analyze how much uplift or subsidence might have happened since the Pliocene and subtracted this from the elevation of the formations they investigated.

One key interval of particular interest during the Pliocene is the mid Piacenzian Warm Period—some 3.264 to 3.025 million years ago—when temperatures were 2 to 3° Celsius higher than pre-industrial levels. "The interval also marks the last time the Earth's atmospheric CO₂ was as high as today, providing important clues about what the

future holds in the face of current anthropogenic warming," Onac says.

This study found that during this period, global mean sea level was as high as 16.2 meters (with an uncertainty range of 5.6 to 19.2 meters) above present. This means that even if atmospheric CO₂ stabilizes around current levels, the global mean sea level would still likely rise at least that high, if not higher, the scientists concluded. In fact, it is likely to rise higher because of the increase in the volume of the oceans due to rising temperature.

"Considering the present-day melt patterns, this extent of sea level rise would most likely be caused by a collapse of both Greenland and the West Antarctic ice sheets," Dumitru said.

The authors also measured sea level at 23.5 meters higher than present about four million years ago during the Pliocene Climatic Optimum, when global mean temperatures were up to 4°C higher than pre-industrial levels. "This is a possible scenario, if active and aggressive reduction in green house gases into the atmosphere is not undertaken", Asmerom said.

More information: Constraints on global mean sea level during Pliocene warmth, *Nature* (2019). DOI: [10.1038/s41586-019-1543-2](https://doi.org/10.1038/s41586-019-1543-2) , www.nature.com/articles/s41586-019-1543-2

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