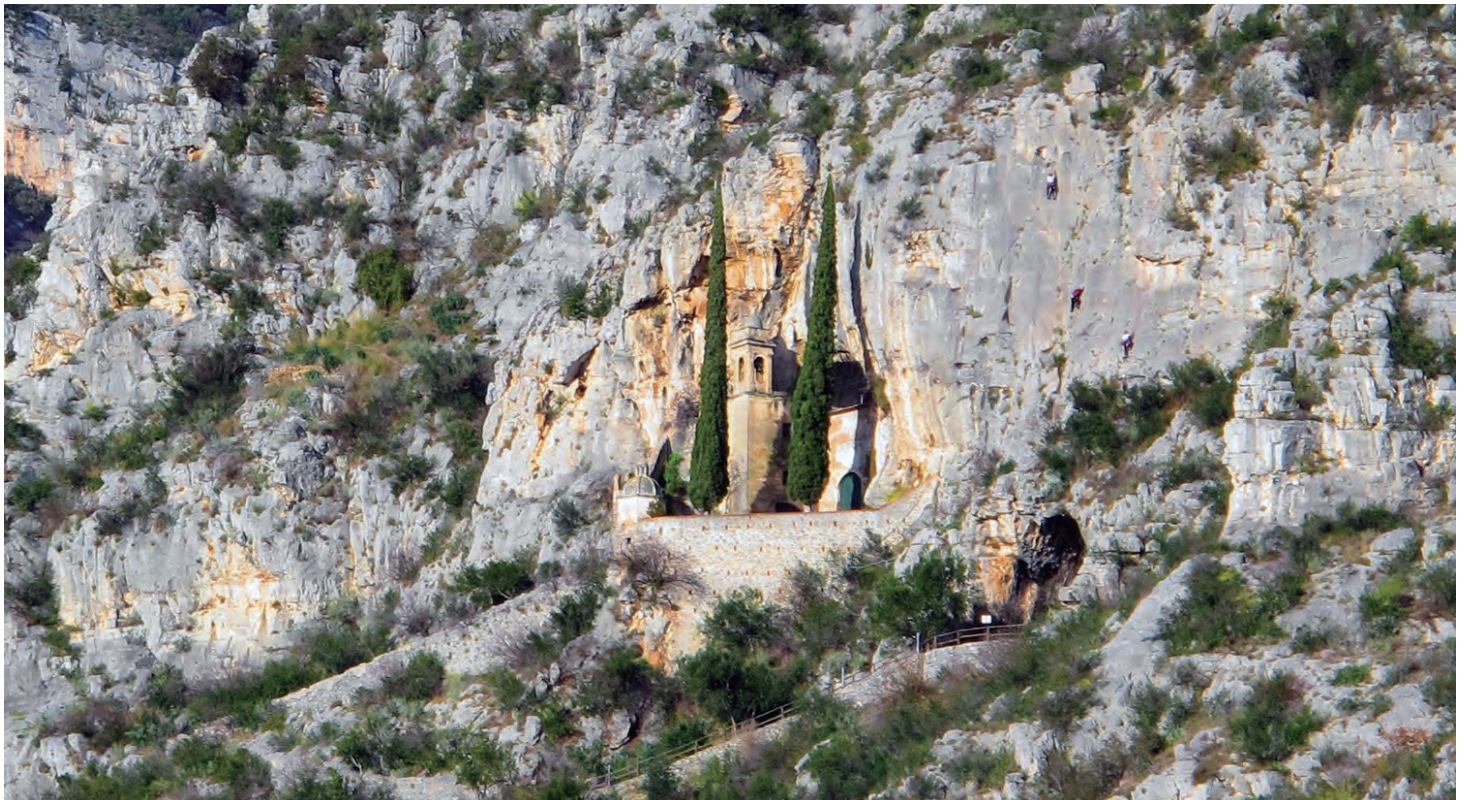


I ACHIEVEMENTS

Unveiling the Mystery of a Dramatic Warming Cycle and the Most Rapid Sea-Level Rise Event of the Past Million Years

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| Distant prospect of Bäsura Cave in Toirano, Savona, in northwestern Italy.

Over the past million years, Earth's climate has undergone regular 100,000-year glacial cycles. After approximately 90,000 years of gradual cooling, each cycle was followed by a relatively rapid phase of deglaciation and warming, known as a glacial termination ("Termination"). Around 340,000 years ago, during the fourth glacial termination (Termination IV, T-IV), Earth experienced an intense rapid warming event, driving the fastest sea-level rise over the past million years. Geological evidence suggests that sea level may have risen as rapidly as 5 m per century, far exceeding the contemporary global average rate of 3–4 mm per year driven by relentless global warming. However, the mechanism behind this extraordinary event remained one of the major unresolved puzzles in Earth science.

Prof. Chuan-Chou Shen of the Department of Geosciences led an international team that conducted drilling speleothem cores in Bàsura Cave located in Toirano, Savona, northwestern Italy. Using uranium-thorium absolute dating techniques, the team established a high-resolved hydroclimate record for the European Westerlies. This chronological framework was then transferred to North Atlantic marine sediment records to reconstruct the precise sequence of climate transitions, ocean circulation changes, regional hydroclimate variability, and rapid sea-level rise during T-IV. The study revealed that the Atlantic Meridional Overturning Circulation (AMOC) remained weakened for 13,000 years during T-IV, the longest duration among the last five glacial terminations, inducing large amounts of heat to accumulate in the deep ocean. Once circulation resumed, ocean heat stored during the prolonged slowdown was rapidly redistributed to high-latitude regions, yielding accelerated iceshelf melting, enhanced ice-sheet instability, and rapid sea-level rise, ultimately triggering this exceptional warming event ⁽¹⁾.

The international team further suggests that if heat accumulated within the ocean interior were to be re-transported under certain conditions to the bases of ice shelves or grounding zones of ice sheets, future sea-level rise would not proceed gradually as a slow and linear process, but instead likely would exhibit much more rapid, potentially threshold-like changes. These findings improve our understanding of possible future sea-level-rise risks and provide important paleoclimate evidence for assessing coastal hazards and developing climate adaptation strategies for coastal cities and low-lying regions.

(1): Hu, H.-M.*, Marino G.*, Goñi M. F. S., Rohling E., Rodrigues T., Pérez-Mejías C., Ren Q., Jiang X., Michel V., Valensi P., Starnini E., Zunino M., Salonen J. S., Hsieh C.-J., Tan L., Chaigneau B., Chevalier M., and Shen C.-C.* (2026) Protracted ocean circulation slowdown drove exceptional ice-sheet melting during ice age termination IV. *Nature Communications* 17, 5675.



Prof. Chuan-Chou Shen of the Department of Geosciences, operating a core drill rig to extract limestone core samples in Bàsura Cave, in northwestern Italy.



Limestone core samples collected at Bàsura Cave. The black-and-white alternating bands represent a scale measured in centimeters. Researchers follow the scale in extracting small subsamples ranging from 0.1 to 100 milligrams for carbon and oxygen isotope analysis, trace element determination, and uranium-thorium dating.



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