

Last Ice Age: Precipitation caused maximum advance of Alpine Glaciers

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Close-up of cryogenic cave carbonates (CCC). Their importance in climate research has only been recognised in recent years. Credit: Christoph Spötl

Geologists from the University of Innsbruck unexpectedly found mineral deposits in former ice caves in the Austrian Alps dating back to the peak of the last ice age. These special calcite crystals demonstrate that intensive snowfall during the second half of the year triggered a massive

glacier advance leading to the climax of the last ice age. The results were published in the journal *Nature Communications*.

The last glacial period, which lasted about 100,000 years, reached its peak about 20,000 to 25,000 years ago: Huge ice sheets covered large parts of northern Europe, North America and northern Asia, some of them kilometers thick, and the sea level was about 125 meters below today's level. The Earth looked very different during this so-called Last Glacial Maximum than it does today. This relatively recent period of the last maximum ice extent has long been of interest to researchers and subject to intensive research.

What actually led to this extreme glacier growth, however, has remained unclear until now. Through findings of special [cave](#) deposits in the Obir Caves in Bad Eisenkappel located in the Austrian state of Carinthia Christoph Spötl, head of the Quaternary Research Group at the Department of Geology at the University of Innsbruck, together with his colleague Gabriella Koltai, made an interesting observation for an interval within the Last Glacial Maximum that lasted about 3100 years. During this period, the ice volume in the Alps reached its maximum.

The data are based on small, inconspicuous crystals, so-called cryogenic cave carbonates (CCC): "These calcite crystals formed when the Obir Caves were ice caves with temperatures just below zero. CCC are reliable indicators of thawing permafrost. These findings mean that, paradoxically, during one of the coldest periods of the last glacial period, the permafrost above these caves slowly warmed up," says Christoph Spötl. Since climate warming can be ruled out at this time, there is only one way for geologists to explain this phenomenon. "There must have been a major increase in solid precipitation in the Alps between 26,500 and 23,500 years ago: There is no permafrost in places with a stable thick snow cover."

Föhn wind caused large amounts of snow

Cold periods are typically also dry, but in the Alpine region this was not the case during this interval, which lasted about 3100 years. "The largest advance of Alpine glaciers in the entire last glacial period took place during this time interval. Precipitation was the key source for the growth of the ice giants—and there must have been a lot of it, especially in autumn and early winter, as the CCC show," says Spötl. "A snow cover of about half a meter has already a strong insulating effect, shields the ground below from the very cold winter air and thus leads to an increased temperature in the subsurface. The permafrost above the Obir caves gradually thawed at that time. This thermal phenomenon, triggered by the shift from an Arctic-dry to a significantly wetter climate, remained preserved in the underground in the form of the CCC until today."

Since the North Atlantic—today a major source of precipitation—was ice-covered in winter at the time, the team assumes a strong southerly flow from the Mediterranean that brought the moisture to the Alps, driven by pronounced southerly föhn conditions. "We consider massive snowfall due to this strong southerly flow as the cause of the growth of glaciers in the Alpine region at the peak of the Last Glacial Maximum. And our data allow us to even pin down the season: autumn and early winter," concludes Christoph Spötl.

Cryogenic cave carbonates have long been overlooked even by experienced speleologists, however, Koltai and Spötl are convinced: "In Austria alone, around 17,500 caves are known, and further discoveries of CCC are only a matter of time. That's why we work closely with speleologists, in the case of the Obir caves with the specialist group for karst and speleology of the Natural Science Association for Carinthia."

More information: C. Spötl et al. Increased autumn and winter

precipitation during the Last Glacial Maximum in the European Alps, *Nature Communications* (2021). [DOI: 10.1038/s41467-021-22090-7](https://doi.org/10.1038/s41467-021-22090-7)

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