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Subglacial Calcites from Northern Victoria Land: archive of Antarctic volcanism in the Last Glacial Maximum

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Subglacial carbonates bear similarities to stalagmites in their fabrics and the potential to obtain precise chronologies using U-series methods. Their chemical properties also reflect those of their parent waters, which, in contrast to stalagmites, are those of subglacial meltwaters. In analogy to speleothems, stable Carbon isotope ratios and trace elements such as Uranium, Iron and Manganese provide the opportunity to investigate ancient extreme environments without the need to drill through thousands of metres of ice.

Sedimentological, geochemical and microbial evidence preserved in LGM subglacial calcites from Northern Victoria Land, close to the East Antarctic Ice Sheet margin, allow us to infer that subglacial volcanism was active in the Trans Antarctic Mountain region and induced basal ice melting. We hypothesize that a meltwater reservoir was drained and injected into interconnected basal pore systems where microbial processes enhanced bedrock weathering and, thus, released micronutrients. Volcanic influence is supported by the presence of fluorine (F) and sulphur in sediment-laden calcite layers containing termophilic species. Notably, calcite δ13C points to dissolved inorganic carbon evolved from subglacial metabolic processes. Once transported to the sea, soluble iron likely contributed to fertilizing the Southern Ocean and CO_2 drawdown.

This is the first well-dated evidence for LGM volcanism in Antarctica, which complements the record of volcanic eruptions retrieved from Talos Dome ice core, and supports the hypothesis of large-scale volcanism as an important driver of climate change.

We conclude that subglacial carbonates are equivalent to speleothems in their palaeoclimate potential and may become a most useful source of information of ecosystems and processes at peak glacials in high altitude/high latitude settings.