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The palaeoenvironmental significance of laminated flowstones in caves: insights from hydrochemical monitoring and isotopic studies

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Flowstones, i.e. sheet-like carbonate formations on cave walls and floors, have played a minor role in palaeoenvironmental studies in the past as most research on speleothems has focused on stalagmites. Given the scarcity of candle stick-type stalagmites in many caves and the stringent constraints on sampling these formation placed by cave conservation, it is likely that flowstones will gain more attention in the near future. Their major advantage is the possibility of multiple sampling by drill cores thereby minimizing damage to the speleothem. Little is currently known, however, about the internal structure, stratigraphy and growth dynamics of flowstones and how these processes are related to hydrology and climate.

We launched a program monitoring a currently active flowstone in a small cave near the village of Pfunds (Tyrol, Austria) in order to gain insights into the processes that govern the composition of various proxy indicators commonly measured in speleothems. Drill cores show that the flowstone is laminated and consists of couplets of thick, translucent calcite laminae alternating with thin, inclusion (organic)-rich laminae. U-series dates in conjunction with lamina thickness measurements suggest an annual origin of these couplets. A seasonal change in calcite precipitation dynamics on the flowstone surface is likely given the close proximity to the cave entrance (ca 10 m). The seasonal temperature amplitude at the flowstone surface is about 10 degrees C. Water analyses taken at regular intervals show a rather constant composition throughout the year, including the stable isotopes of carbon and oxygen. Contrary to our expectations, stable isotope data of modern calcite precipitates collected on glass slides and plastic foil on several spots on the flowstone surface do not show a clear-

cut difference between winter and summer. This is corroborated by high-resolution isotope studies of late Holocene sections of the flowstone which lack significant intralaminar isotopic differences. Instead, we observed a variability of strongly covariant carbon and oxygen isotope data on a decadal time scale. Although the origin of this variability is not fully understood yet, our data suggest that the annual-scale isotopic signal stored in the calcite is overwhelmed by a much larger, decadal variability, interpreted as dry and warm years alternating with more humid years. Because of its shallow depth this cave apparently acts as an amplifier of a multi-annual climate signal difficult to see in instrumental records.