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Speleothem calcite crystal fabrics and isotopic signatures, Northern Yukon Territory, Canada

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Speleothem are rare in high-latitude and high-altitude caves, which makes Bear Cave a particularly interesting case, as it houses some of the oldest and highest latitude speleothem in the world. Located at the Arctic Circle in the north-western Yukon Territory, these deposits were shielded from the onslaught of the Quaternary glaciations in the ice-free corridor of Beringia. A 68 cm thick flowstone (BC1) recovered from the cave is characterized by well defined crystal structures and distinct colour variations, which makes it an excellent specimen for crystallographic and geochemical analysis. ^{4}He-dating carried out at the University of Heidelberg in Germany places the top of the flowstone around 3.23 +/- 0.65 Ma, nearing the Tertiary-Quaternary boundary. Preliminary ^{4}He dating at the MAPL Noble gas laboratory at the University of Ottawa has provided ages close to 5 Ma. New measurements of ^{4}He ingrowth now focus on smaller mineral grain separates to improve the chronology of BC1. The purpose of this study is twofold. The information preserved in these cave formations will aid in expanding our knowledge of what the environmental and climatic conditions were like in the region preceding the Quaternary, when permafrost was absent from the area. More importantly, investigation of the changes in crystal fabrics and the variations in their respective isotopic signatures will aid in understanding speleothem depositional processes and their influence on speleothem climate proxies.

A continuous record of δ^{18}O and δ^{13}C was completed along the growth axis of BC1, including a complimentary crystallographic study. The mean δ^{18}O content of modern precipitation in the region is approximately -22‰ whereas the mean value observed in the flowstone from Bear Cave is -17‰ with extreme values around -19‰ and -15‰ consistent with other interglacial deposits in the Rocky Mountains of British Columbia and Alberta. δ^{13}C values were found to range between -4‰ to -8‰. The strongest variations were observed at both ends of the flowstone, with abrupt shifts located at major discontinuities, however a crystallographic study suggests these may be recrystalization zones. A total of eight distinctly different microfabrics were identified in the flowstone, including a softer microcrystalline group, a harder tightly packed columnar-type group, and a transitional group consisting of loosely packed columnar crystals with softer microfabrics in-filling the intercrystalline boundaries. When applying the stable isotope record to the crystallographic study, it was found that the microfabrics occurred over different isotopic ranges. Three of the eight microfabrics exhibited weak linear correlations between $\delta_1$8O and $\delta_1$3C, representing the soft and transitional fabric groups. This may be related to kinetic effects at the time of deposition or post-depositional diagenesis. Recrystallization was observed in some of the porous microcrystalline layers, however SEM analysis revealed that some of the coarser fabrics may not have been subject to secondary infiltration waters. This study suggests that the softer fabrics were likely subject to disequilibrium conditions at the time of deposition, and the transitional fabrics are most likely the result of post-depositional diagenesis, and not representative of initial deposition. Both of these conditions may obscure the original climatic signal, therefore caution should be heeded when trying to interpret paleo-information from specific microfabrics.