



A Preliminary Stable Isotope Record of Six Interglaciations from Whiterock Cave, Utah, USA

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Whiterocks Cave is a solution cave on the southern flank of the Uinta Mountains in northeastern Utah, USA. The entrance to the cave, which has a mapped length of 803 m and a vertical extent of 20 m, is at an elevation of 2600 m in a cliff of Mississippian-age Madison Limestone. To investigate the potential of speleothems to provide information about paleoclimate conditions in this area, 3 stalagmites were collected from the cave in 2017 with the assistance of the US Forest Service. Stal-B, composed of white calcite lacking any visible unconformities, is 17 cm tall. Stal-C is the broken top (21 cm) of a larger stalagmite found near the back of the cave. Stal-D is a 24-cm tall stalagmite collected near the cave entrance. Both Stal-C and Stal-D contain numerous visible unconformities. Preliminary age models for these samples were established using U-Th ages ($n=31$) determined at the Massachusetts Institute of Technology. Stable isotopes were analyzed at an interval of 0.2-mm through these samples at the University of Innsbruck. Ages for these samples range from 118 ± 0.6 ka BP to the limit of U-Th dating (~ 600 ka BP). Five ages demonstrate that Stal-B accumulated during Marine Isotope Stage (MIS)-5 (118-126 ka BP). In contrast, the uppermost part of Stal-C accumulated during MIS-11 (or possibly MIS-9) and lower parts of this sample represent deposition during MIS-13 and MIS-15. Stal-D grew intermittently between MIS-5 and MIS-11. Despite the preliminary nature of the age control, this pattern strongly suggests that these speleothems only grew during intervals aligned with the six interglaciations from MIS-5 to MIS-15. Given the elevation of the cave and geomorphic evidence for extensive alpine glaciation nearby, it is likely that permafrost existed above the cave for most of the past 600,000 years, blocking water infiltration and limiting speleothem growth to peak interglacial conditions. Lapse rates calculated from long-term temperature monitoring in this area suggest that the modern 0°C isotherm is at an elevation of 3150 m, requiring a drop of ~ 350 m to reach the ridgeline above the cave. Also notable is that values of $\delta^{18}\text{O}$ were from -13.5 to -11.5‰ during MIS-7, but -14.5 to -13‰ in MIS-13. Other interglaciations had values near -13‰ that are between these two extremes. This contrast suggests that the relative abundance of precipitation from different sources, or different seasons, varied between interglaciations.