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Evaluating bias on experimental growth rate of cave calcite deposit growth and implications for cave monitoring studies

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Speleothems are cave calcite deposits used in paleoclimate research, because of their potential to preserve climate information via variations in their growth rates. Recently, monitoring studies have significantly advanced our understanding of speleothem growth. For example, one monitoring study has shown that drip rate is not the only factor of speleothem growth, which is contradictory to 20 years of cave studies (Banner et al. 2007). This study was conducted by growing calcite under active drip sites, using flat, 10 cm x 10 cm glass plates as a substrate. A major assumption of this approach is that these flat glass plates accurately simulate the surface of the speleothem. The current study seeks to test the validity of this assumption in the same cave as the Banner et al. (2007) study at Innerspace Cavern in Georgetown, TX. The methods tested the control of a variety of substrate properties, including material, surface roughness, and morphology. The goal of this study is to address three questions: 1.) Does the method of determining calcite growth using a flat glass plate accurately represent the growth of calcite on a natural speleothem such as a stalagmite with a curved growth surface? 2.) Does using an artificial substrate material such as glass differ in calcite growth rate compared to other substrates, including metal, sanded glass, natural speleothem calcite, and calcite spar? 3.) Is the natural speleothem crystal morphology of calcite the same as the morphology of calcite grown artificial substrates?

To address the first question, we deployed both curved and flat plates at the same drip site, and then measured the resulting growth rate. Calcite growth rates on both curved and flat plates varied seasonally, with higher growth rates in the winter than the summer. This seasonality is consistent with previous studies and indicates a control by seasonal cave-air CO_2 fluctuations. The magnitude of the growth rate is similar for curved and flat plates, indicating that using flat plates does not introduce a significant bias in growth rate results relative to the curved surfaces of natural speleothems. Sanded glass substrates show more calcite growth than unsanded glass substrates, consistent with a nucleation site control on growth. Substrate surface area co-varies linearly with calcite growth rate, for all substrate materials, suggesting that the type of substrate is not a significant factor in calcite growth in this cave setting. SEM analysis is underway to compare the crystal morphology of modern plate calcite to that of natural speleothems.

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