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Clumped isotope thermometry in Calcite from oxalate and Earthworm

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Exploring the thermal history of past Terrestrial environments can be achieved through the application of clumped isotope (Δ_{47}) thermometry on soil carbonates [1,2]. These carbonates are formed through earthworm secretion and the oxalotrophic bacterial transformation of oxalates within a plant [3,4]. In this study, we elucidate the correlation between the precipitation temperature of these carbonates and their clumped isotopic composition (Δ_{47}) by examining laboratory-synthesized calcites as final products. The carbonate secreted by the earthworm *Lumbricus terrestris* at controlled temperatures of 5°C, 10°C, 16°C, 18°C and 20°C. The linear regression equation obtained from our experimentation is expressed as:

$$\Delta_{47} = (0.0592 \pm 0.0072) * (10^6 / T^2) + (0.0322 \pm 0.0868)$$

Here, T represents temperature in Kelvin. The slope obtained from our regression analysis mirrors closely that observed in experiments involving both inorganic calcite precipitation [5]. Similarly, carbonate precipitation was induced using the oxalotrophic bacterium *Stenotrophomonas sclerotiorum*, cultivated in a medium comprising peptone, sodium chloride, yeast extract, and calcium oxalate, across a temperature range from 20°C to 40°C. The resulting linear regression equation derived from this experiment is:

$$\Delta_{47} = (0.0384 \pm 0.0018) * (10^6 / T^2) + (-0.0207 \pm 0.0868)$$

This regression slope aligns closely with paleosol carbonates [1]. However, notable variation was observed in the intercept of the equation, indicating differences in carbonate growth rates. This study elucidated a possible mechanism of microbial intervention in soil carbonate precipitation in transforming abundant oxalate to carbonates.

Reference:

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