Effects of high-frequency cave atmosphere P_{CO2} variability on stalagmite climate proxy records

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Fifteen months of high-resolution (hourly) P_{CO_2} measurements from two shallow temperate zone caves in SW Ireland demonstrate considerable annual and subannual variability caused predominantly by soil temperature fluctuations. First-order shifts occur between summer and winter, while superimposed second-order variability is principally derived from shorter term variations in soil temperature, explicable by using a power function derived from previous soil CO_2 modelling (Murthy et al., 2003). A 'biological pump' mechanism likely forces soil CO_2 downward into the caves, though degassing of dissolved CO_2 from cave drips also contributes to CO_2 accumulation.

Stalagmite growth rates are affected by ambient P_{CO_2}, but the strength of this effect is drip-site dependent. The growth rate and geochemistry of stalagmites fed by slower, well-buffered drip waters appear most influenced directly by cave atmosphere P_{CO_2} variations. Consequently, the growth rates of these stalagmites vary significantly both seasonally and on shorter timescales, directly paralleling cave atmosphere P_{CO_2}. Conversely, calcite deposition on stalagmites fed by more poorly-buffered drips is affected by the difference between soil P_{CO_2} and cave P_{CO_2}, resulting in a potential anticorrelation between the growth rates of these sites compared to those of well-buffered sites.

Because soil temperature directly affects cave atmosphere P_{CO_2} (and consequently stalagmite growth rates), geochemical records in stalagmites that are influenced by growth rate (e.g., Sr^{2+}) may partially record soil temperature conditions. Additionally, the observed P_{CO_2} variations will significantly affect the $\delta^{13}C$ signature of any calcite precipitated, but the direction of the $\delta^{13}C$ shift may vary depending on the flow regime of the drip feeding the stalagmite.

References

[1] Murthy, R., Griffin, K. L., Zarnoch, S. J., Dougherty, P. M., Watson, B., Van Haren, J., Patterson, R. L., and Mahato, T. (2003) *Forest Ecology and Management*, **178** 311-327.