

Seasonal changes in the formation time of pedogenic carbonates on the Chinese Loess Plateau during Quaternary glacial cycles

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Pedogenic carbonates document abundant paleoenvironmental information. However, the seasonality of pedogenic carbonate formation varies under different climate regimes, obscuring the interpretation of long-term records derived from this archive. Here we report evidence of the changing seasonality of pedogenic carbonate growth from the Chinese Loess Plateau during the Pleistocene glacial cycles. The $d^{18}O$ of pedogenic carbonates ($d^{18}O_c$) formed during the interglacial periods generally show positive correlations with proxy-inferred rainfall amounts, opposite to the patterns in the glacial periods. We interpret these patterns using modern observations and modeling efforts and identify diverse correlations between $d^{18}O_c$ and rainfall amount in the growing season (June-September) versus the non-growing season (March, April, October, November) across the Chinese Loess Plateau. We propose that in glacial episodes under weak summer monsoon, rainfall events and rainfall-driven pedogenic carbonate growth occurred within the growing season, leading to a negative $d^{18}O_c$ -rainfall correlation. Conversely, rainfall events and pedogenic carbonate growth extended into the non-growing season during the interglacial episodes under intensified summer monsoon, incorporating a positive $d^{18}O_c$ -rainfall correlation. Our work links seasonal fluctuations of pedogenic carbonates with their long-term records, shedding new light on interpreting this paleoenvironmental archive.