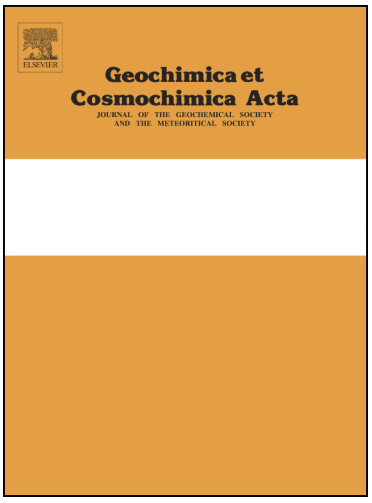

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Clumped isotope constraints on equilibrium carbonate formation and kinetic isotope effects in freezing soils

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Abstract

The clumped and stable isotope (Δ_{47}, $\delta^{18}O$, and $\delta^{13}C$) composition of pedogenic (soil) carbonates from cold, arid environments may be a valuable paleoclimate archive for climate change-sensitive areas at high latitudes or elevations. However, previous work suggests that the isotopic composition of cold-climate soil carbonates is susceptible to kinetic isotope effects (KIE). To evaluate the conditions under which KIE occur in cold-climate soil carbonates, we examine the Δ_{47}, $\delta^{18}O$, and $\delta^{13}C$ composition of soil carbonate pendants from Antarctica (Dry Valleys, 77°S), the High Arctic (Svalbard 79°N), the Chilean and Argentinian Andes, and the Tibetan plateau (3800-4800 m), and compare the results to local climate and water $\delta^{18}O$ records. At each site we calculate the expected equilibrium soil carbonate Δ_{47} and $\delta^{18}O$ values and estimate carbonate Δ_{47} and $\delta^{18}O$ anomalies (observed Δ_{47} or $\delta^{18}O$ minus the expected equilibrium Δ_{47} or $\delta^{18}O$). Additionally, we compare the measured carbonate $\delta^{13}C$ to the expected range of equilibrium soil carbonate $\delta^{13}C$ values. To provide context for interpreting the Δ_{47} and $\delta^{18}O$ anomalies, the soil carbonate results are compared to results for sub-glacial carbonates from two different sites, which exhibit large Δ_{47} anomalies (up to -0.29 ‰). The Antarctic and 4700 masl Chilean Andes