

# Carbon and oxygen isotopes and trace element ratios of different types of CaCO<sub>3</sub> in the Chinese loess–paleosol sequence and their paleoclimate implications

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Geochemistry data of calcium carbonate (CaCO<sub>3</sub>) is crucial for reconstructing past environmental variations, but the different types of CaCO<sub>3</sub> (biogenic, pedogenic, and geogenic carbonates) can influence the results [1,2]. In this study, the trace element ratios, and carbon and oxygen isotopes of CaCO<sub>3</sub> from the Chinese loess–paleosol sequence are evaluated.

Our results showed that the differences in carbon and oxygen isotopes among those carbonates were not controlled by their different mineral phases but by their formation seasons and duration. Land snail shells formed in active seasons from spring to fall for 1-2 years [3], pedogenic carbonate grew for hundreds of years with different growth seasons under different climate regimes [4], and geogenic carbonate might consist of primary carbonate. Unlike the isotope compositions, the trace element ratios are sensitive to the element sources and post-preservation process. The B/Ca and Mg/Ca ratios can identify primary and secondary carbonates, and the Al/Ca ratio can record the diagenesis process. Combining isotope compositions with trace element ratios, we found that the oxygen isotope of pedogenic and geogenic CaCO<sub>3</sub> is strongly related to the Na/Al, Ba/Ca, and Sr/Ca ratios, which indicated that those trace element ratios can also record variations in monsoon. Our study highlights the importance of caution when using different types of carbonates for paleoclimate research due to their variable geochemistry data caused by the formation and post-preservation processes.

[1] Zamanian et al.(2021), *Quaternary Research* 101, 256-272.

[2] Luo et al. (2020), *Journal of Asian Earth Sciences* 201, 104515

[3] Bao et al. (2023), *Geology* 2022 51 (2): 179–183.

[4] Da et al. (2023), *Quaternary Science Reviews* 305, 108008.