Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.28748

Incorporation of trace metals into land snail shells on the Chinese Loess Plateau as novel proxies for paleo-precipitation

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Terrestrial mollusks, particularly land snails, have been recognized as typical 'index animals' due to their sensitivity to climate change. Land snails are widely distributed in the semi-arid to arid regions of China, such as the Chinese Loess Plateau (CLP), and abundant fossil shells are preserved in the loess deposits on the CLP, serving as a valuable archive for paleoclimate reconstruction. The incorporation of trace metals into land snail shells may record the ambient environmental conditions, yet this potential remains largely unexplored. In this study, we analyzed modern snail shells (*Cathaica sp.*) collected from sixteen sites across the CLP to investigate their trace metal compositions. Our results show that both Sr/Ca and Ba/Ca ratio exhibits minimal intra-shell variability and small inter-shell variability at individual sites. A significant positive correlation is observed between the shell Sr/Ca and Ba/Ca ratios across the plateau, with higher values being recorded in the northwestern sites where less monsoonal rainfall is received. We propose that shell Sr/Ca and Ba/Ca ratios, which record the compositions of soil solution, may be controlled by the Rayleigh distillation in response to prior calcite precipitation. Higher rainfall amounts may lead to a lower degree of Rayleigh distillation and thus lower shell Sr/Ca and Ba/Ca ratios. This is supported by the distinct negative correlation between summer precipitation and shell Sr/Ca and Ba/Ca ratios (Figure 1), enabling us to reconstruct summer precipitation amounts using the Sr/Ca and Ba/Ca ratios of *Cathaica sp*. shells. The potential application of these novel proxies may also be promising for other terrestrial mollusks living in the loess deposits globally.