Study reveals early diagenetic processes of fossil land snail shells from the Chinese Loess Plateau

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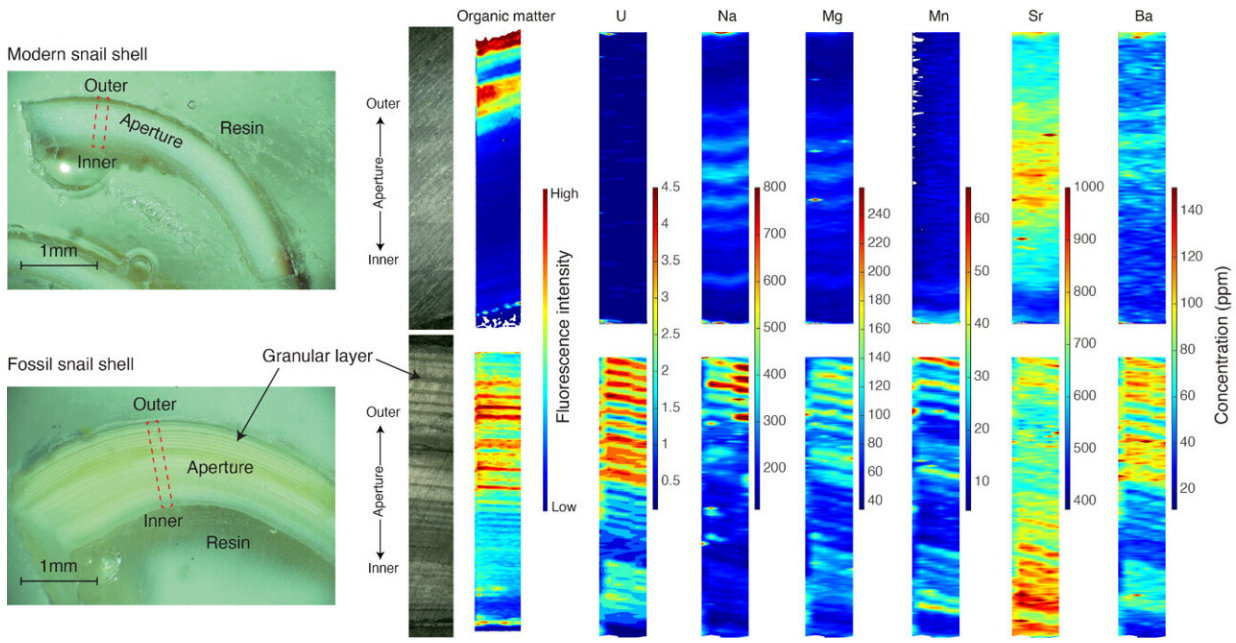

Raman fluorescence and elemental mapping across the aperture part of both modern and fossil Cathaica sp. shells. Credit: NIGPAS

Terrestrial mollusks are considered as typical "index animals" due to their sensitivity to climate change. They are widely distributed in the semi-arid to arid region of China, including the Chinese Loess Plateau (CLP).

Despite the wide application of geochemical proxies of fossil snail shells in paleoclimatic reconstruction, the extent that they were influenced by the diagenetic alteration remains unknown.

Researchers led by Associate Professor Li Tao from the Nanjing Institute of Geology and Paleontology of the Chinese Academy of Sciences (NIGPAS) and their collaborators investigated the U-series isotope geochemistry as well as the early diagenetic imprints of fossil land snail shells (Cathaica sp.) from the Mangshan loess-paleosol sequence in Henan province, central China.

They employed several geochemical techniques to investigate the mineralogy, chemical and isotopic compositions of both modern and fossil snail shells to the micrometer level.

The findings were published in *Quaternary Geochronology*.

"Land snail shells can be absolutely dated, and U-Th dating is a very powerful technique due to its wide age coverage (0 to 640,000 years) and solid theoretical foundation," said Li.

However, obtaining accurate U-series dates from both marine and terrestrial mollusk shells has remained challenging. A major issue is that a significant amount of U in the shell is incorporated during the diagenetic episode after the burial of the shell into the sediment.

On the CLP where fossil snail shells can be buried and isolated quickly from the influence of meteoric water due to the relatively high sedimentation rate of eolian dust and the semi-arid to the arid climate, it is possible that diagenesis might occur only in the very early stage when pore-water is still able to alter the composition and structure of the snail shells. Therefore, land snail shells on the CLP may serve as a datable archive that can be used for U-Th dating.

The Raman and SEM observations showed that the fossil shell was characterized by an elevated degree of porosity and a higher content of organic matter. The trace elemental composition of the fossil Cathaica sp. shell had also been largely reset, which is linked to the diffusion and adsorption of organic matter into the fossil shell during the early diagenetic alternation of fossil Cathaica sp. shells.

The U-series data showed that [$^{234}U/^{238}U$] and [$^{230}Th/^{238}U$] values were relatively homogeneous throughout the shell and the calculated apparent U-Th dates were within analytical error consistent with corresponding solution MC-ICPMS results, demonstrating the homogeneous distribution of [$^{234}U/^{238}U$] and [$^{230}Th/^{238}U$] within the fossil Cathaica sp. shells.

However, the apparent closed system U-Th ages of fossil Cathaica sp. shells are found to be systematically younger (~6,000 to 13,000 years) than their paired shell ^{14}C ages. By evaluating possible U uptake scenarios, the researchers suggest that this apparent age discrepancy is related to the early diagenetic uptake of U and later close system behavior likely due to the isolation of fossil shells from the influence of pore waters.

More information: Tao Li et al, Early diagenetic imprints and U–Th isotope systematics of fossil land snail shells from the Chinese Loess Plateau, *Quaternary Geochronology* (2022). DOI: 10.1016/j.quageo.2022.101417

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