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Zinc isotopes in tooth enameloid unravel the palaeoecology of Late Cretaceous sharks

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Zinc isotope ratios ($^{66}Zn/^{64}Zn$), reported as $\delta^{66}Zn$ value, are used as a novel trophic-level proxy that is increasingly applied to address archaeological and palaeobiological research questions. While the traditional trophic proxy $\delta^{15}N$ increases in numerical value with trophic position, $\delta^{66}Zn$ values decrease. Thus, like $\delta^{15}N$, $\delta^{66}Zn$ allows inferring the position of an organism in relation to the energy transfer from the bottom to the top of a food web. If pristine $\delta^{66}Zn$ values are preserved in fossils, their analysis allows for reconstructing the role of biota in the palaeoenvironment. Due to its hypermineralised nature, tooth enameloid has a high potential to preserve primary, i.e. biological, geochemical signals even on geological timescales. Indeed, pristine biological shark enameloid $\delta^{66}Zn$ values preserve at least as far back as the Miocene.

Here we analyse enameloid $\delta^{66}Zn$ values of Late Cretaceous sharks, thereby exploring the potential for enameloid $\delta^{66}Zn$ values to investigate the food web structures and trophic positions of sharks even further back in time. Our samples come from the Western Interior Seaway (WIS), a major epicontinental sea that divided North America during the Late Cretaceous with rich ecosystems that hosted a wide variety of marine life. We focus on specimens from two Upper Cretaceous (Turonian-Coniacian transition) localities in the USA, the Tocito Sandstone-Mulatto Tongue of the Mancos Shale in New Mexico and the Codell Sandstone Member of the Carlile Shale in Kansas. Our results demonstrate well-preserved enameloid $\delta^{66}Zn$ values in both localities, but locality-specific differences in the diagenetic modification of dentine $\delta^{66}Zn$ values. We find significant resource partitioning among the 16 analysed taxa within the WIS. This new study expands the use of enameloid $\delta^{66}Zn$ analyses much deeper into geological time than before to demonstrate robust reconstructions of food web dynamics and trophic interactions in late Mesozoic marine ecosystems.