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Shark teeth: a new U isotopic archive for paleoredox reconstruction?

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The seawater $\delta^{238}U$ value is a widely-utilized proxy for marine anoxia, which takes advantage of the significant isotopic fractionation during U removal from seawater into anoxic/euxinic sediments [1]. The application of the U redox proxy requires a faithful archive that records the original seawater $\delta^{238}U$ value. However, there is increasing scrutiny of the most popular archive – carbonates – whose $\delta^{238}U$ is subject to diagenetic alteration after deposition. Therefore, it is worth exploring other archives that may record and preserve the original $\delta^{238}U$ signal from seawater.

Here, we investigate the feasibility of using shark teeth as a novel archive for seawater $\delta^{238}U$. Shark teeth, as crystalline apatite, are more resistant to post-depositional alteration than marine carbonates due to their lower solubility and general insensitivity to isotopic exchange. These characteristics have, for instance, helped establish fossil fish teeth as a powerful archive of Nd isotopes in seawater [e.g., 2 and references therein], with Nd being incorporated post mortem during early sediment burial and fossilization from apatite to hydroxyfluorapatite. As U can be readily incorporated into phosphates, fish/shark teeth could similarly incorporate and preserve the original seawater $\delta^{238}U$ composition.

To test whether U isotopes in shark teeth can record past seawater signatures, we measured U isotopes in 31 shark teeth from various locations (e.g., Peru, the Gulf of Mexico, and the Arctic), ranging in age from modern to Pliocene. We found that U concentrations are negligible in modern teeth, but elevated in fossil samples (from several to several hundred ppm), indicating that U is incorporated into shark teeth postmortem during burial. The $\delta^{238}U$ values range from -0.52‰ to 0.32‰, which is comparable to the variability observed in marine carbonates [3, 4]. We will discuss the origin of these $\delta^{238}U$ variations and evaluate the feasibility of using shark teeth as a new archive of seawater $\delta^{238}U$.

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