

Initial and Diagenetic Behaviour of U Isotopes in Corals: Implications for U-series Dating

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U-series isotopes in corals are one of the most powerful tools for chronometry in Quaternary Paleooceanography. Modern mass spectrometric techniques routinely reach 1 permil precision for the isotopic ratios of uranium and thorium. However, the corals themselves are often found to be open systems for U-series dating. The most widely used metric for diagenetic alteration of the age is the deviation of the $\delta^{234}\text{U}$ ratio from the seawater value of 146‰. In this study we use deep-sea corals that live and are preserved in a constant seawater environment to investigate the causes of this diagenetic alteration. Coral thin-sections display complex visible banding patterns based on the crystal morphology. Fission track maps and MC-ICP-MS measurements performed on micro-milled sub-samples reveal a primary [U]-variability that has a spatial distribution closely related to the visible banding. Sub-samples from fossil corals, ranging in age from 11 ka to 218 ka, have variable $\delta^{234}\text{U}_{\text{initial}}$ with the highest $\delta^{234}\text{U}_{\text{initial}}$ values in areas of low [U]. A model shows that most of the variability can be explained by two simple processes, direct transfer of alpha recoil ^{230}Th and ^{234}Th and, more importantly, preferential movement of alpha-decay mobilised ^{234}U . Coupling this preferential movement with a high [U] coating such as an organic film provides a source of ^{234}U to the coral lattice that can account for large $\delta^{234}\text{U}_{\text{initial}}$ elevations, with little change to the final age. As surface corals also have large initial [U] gradients, our results demonstrate that many elevated $\delta^{234}\text{U}_{\text{initial}}$ values are a natural consequence of the coral's initial [U] gradient. These gradients are biologically induced at the time of calcification and are an example of how better understanding the effects of biomineralization can improve our interpretation of paleotracers.