U/Th open-system behavior in fossil corals: An applicability test of alpha-recoil based model

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U/Th open-system behavior is an outstanding problem in dating fossil corals. Although some models have been successfully applied in obtaining open-system coral ages, the behavior has not yet been satisfyingly characterized. Here we applied Thompson et al. model to published fossil coral U/Th data covering the last interglacial (LIG) period and our LIG-and-older dates from Sumba Island, Indonesia, to test the degree to which the open-system behavior could be attributed to alpha-recoil process. The results show a clear threshold of sample $\delta^{234}U_{ini}$ ~ 170‰ in evaluating the robustness of model ages. Samples with $\delta^{234}U_{ini}$ < 170‰ perform a good linearity between $^{230}Th/^{238}U$ and $^{234}U/^{238}U$ from additional source (additions, other than from ^{238}U decay in a closed-system). Model ages of fossil corals from Sumba Island and west Australia show a more reasonable timing (~130 ka) of the last interglacial sea-level highstands, being consistent with the current understanding. However, open-system model ages of fossil corals with $\delta^{234}U_{ini}$ > 170‰ are less reliable, and even show scattered dates on samples from same blocks. Moreover, the back-calculated $^{230}Th/^{234}Th(^{234}U)$ ratios of additions are far beyond the ratios from the alpha-recoil model. These lines of evidence indicate that the dominant source controlling the open-system behavior on high $\delta^{234}U_{ini}$ fossil corals is not from alpha-recoil. It could result from internal sources, e.g. crystal diagenesis, and/or from external sources, e.g. underground water. In each case, the $^{230}Th/^{234}Th(^{234}U)$ ratio of the source should be much higher than that of the alpha-recoil process.