Decadal U-Th age shifts from marine alteration of drowned reef corals of the last glacial termination

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Very accurate timing of several-century long events such as melt water pulses during the last glacial termination are crucial for our understanding of the forcing mechanisms for rapid climate and sea level excursions, and for quantification of ice loss models, with implications for future ice loss predictions. Mass spectrometric U-Th dating of shallow water coral skeletons is a gold standard proxy record of sea level change events because of its high precision and straight-forward systematics; when corals are from tectonically stable near-shore settings, absolute magnitudes of sea level change can also be reconstructed. Age resolution of 2-3 decades on specimens aged 10-20 ka is possible in the best cases. Nevertheless, post depositional alteration and diagenesis can affect Th-U ages, which this study strives to quantify.

Our group has been working on submersible mapping and dating an extensive, intact, in growth position, tectonically stable, massive fringing complex at Penguin Bank Hawaii that records Termination 1 from initiation into the Holocene. The paleo reef is currently in 100m to 165m water depth and experiences depth variable amounts of modern marine mesophotic biological activity. This activity manifests itself as coralline algae overgrowths, coral skeletal discoloration, animal borings, and sponge growth on/in reef coral skeletons.

In an effort to quantify the potential effect on U-Th ages from these mesophotic processes, we examined a series of 8 coral specimens collected from our previously determined depth and age range of melt-water pulse 1a. In each case a sub sample of the visually most pristine and visually altered skeletal elements were analysed and compared for U-Th isotope variations and age, as well as Sr/Ca variations by FET microprobe analysis of thin sections. Most samples show minor formation of inorganic aragonite needles in the pore spaces of the specimens and normal Sr/Ca. All but one pair of subsamples and replicates demonstrate near ideal delta-U^{234} values of 141 to 145. Remarkably, in each case the age deviation between pristine and disturbed portions of the specimens ranged from just 5 to as much as 31 years, essentially within or close to the external precision of the analysis. This pilot study indicates that it is possible, through careful screening and pre-treatment, to recover accurate U-Th ages of marine mesophotic altered corals of the last ice age for paleoclimate studies.