Sea-level change in Tongatapu, the Kingdom of Tonga for the last 3000 years based on local marine reservoir effect and geophysical modeling

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Reconstructing the history of Holocene relative sea levels around Tonga provides essential constraints on the recent geological evolution of this region and paleoenvironmental context for archaeological studies. However, there are few sea-level records currently available from the region, and no quantitative paleoenvironmental studies using geochemical/physical methods have been reported. In this study, we reconstruct sea-level histories for Tongatapu island using radiocarbon measurements and glacio-hydro-isostatic adjustment (GIA). Our analyses suggest that changes in the average size of bivalves (Gafrarium tumidum) are synchronous with corresponding changes in the paleoenvironment. These changes also correspond to the timing of the increase of local marine reservoir effects (ΔR) from 219±78 to 376±69. Sea surface salinity (SSS) changes within Fanga ' Uta lagoon were also synchronous with these changes caused by a gradual decrease in the exchange of water in and out of the lagoon. Salinity seems to have been higher than present at approximately 2.6 cal kyr BP, suggesting an embayment that was relatively open to the ocean. Predicted mid-Holocene sea level height using GIA modeling indicates less than 1 m above sea level in Tongatapu, suggesting that previously reported observations of mid-Holocene high stand require additional factors other than GIA. Furthermore, present-day satellite-based observed (i.e., GPS) vertical uplift rate in Tongatapu is ten orders of magnitude higher than the long-term uplift rate obtained from Holocene sea-level data.

Keywords: Holocene, Southern Pacific, Local marine reservoir effect, GIA modeling, Bivalves

