Paleoenvironmental reconstruction in the Kingdom of Tonga during the Holocene using bivalves

*Fukuyo Naoto[1,2], Yusuke Yokoyama[1], Geoffey Clark[3], Kaoru Kubota[4], Yosuke Miyairi[1], Naoko Sugihara[1], Shirai Kotaro[1], Tomihiko Higuchi[1], Toshihiro Miyajima[1]

1. Atmosphere and Ocean Research Institute, The University of Tokyo, 2. Department of Earth and Planetary Science, The University of Tokyo, 3. Archaeology and Natural History,College of Asia and the Pacific,The Australian National University, 4. Kochi Institute for Core Sample Research, JAMSTEC

South Pacific Convergence Zone (SPCZ) fluctuation largely affects the climate in the South Pacific islands. Current climate models have difficulties projecting the movement of the SPCZ. Therefore, paleoclimate records are important to understand SPCZ’ s variability. Additionally, it is suggested that the maritime dispersal in South Pacific during the late-Holocene was affected by sea level pressure and wind field pattern changes. Moreover, environmental changes in South Pacific islands, such as sea level changes, could be a main factor of the migration because of islands with low carrying capacities. However, these previous studies discussed historical human migration without quantitative geochemical records. The objective of this study is to reconstruct paleoenvironment of Tongatapu Island, The kingdom of Tonga, using geochemical analyses of shells of the bivalve *Gafrarium tumidum* and seawater. Tonga is under the influence of SPCZ and was a source area for the migration to East Polynesia around 1000 years ago, thus it is suitable for studying paleo–SPCZ and its relation to human migration. Fossil *G. tumidum* is often excavated from archaeological sites in South Pacific. Thus, geochemical analysis of this species is also important in archaeological studies. Bivalve shells are ideal archives of paleoenvironment changes as they have a growth line which enables us to reconstruct high-resolution records of climate, such as tree rings and reef-building corals. However, few studies have evaluated potential of *G. tumidum* as a paleoenvironmental recorder. Therefore, we assessed them using geochemical analyses of live-caught shells and fossil shells of *G. tumidum*, and seawater collected from Tonga. We measured $\delta^{18}O$ using isotope ratio mass spectrometry (IRMS) and Sr/Ca and Mg/Ca ratios using laser ablation high resolution inductively coupled plasma mass spectrometry (LA-HR-ICPMS) along the maximum growth axis of the shell. Moreover, we calculated a local marine radiocarbon reservoir ages (ΔR) from ^{14}C-ages of fossil shells measured using single-stage-accelerator mass spectrometry (Single-Stage-AMS). We also monitored sea surface temperature (SST) *in situ* for one year and measured sea surface salinity (SSS) using portable salinometer and $\delta^{18}O$ using cavity ring-down spectroscopy (CRDS). Furthermore, we reconstructed relative sea level around Tonga using glacial isostatic adjustment (GIA) modeling. The results suggested: 1) $\delta^{18}O$ of *G. tumidum* shell can record about 3 yr SST variation in monthly to seasonal time resolution; 2) Sr/Ca of *G. tumidum* shell are controlled by the growth rate; 3) the growth of *G. tumidum* is likely controlled by SSS, not by SST, 4) the lagoon of Tongatapu island was isolated continuously from the open ocean between ~2.6 ka and modern; and 5) The average $\delta^{18}O$ of *G. tumidum* in each era can record paleoclimatic snapshots.

Keywords: Calcium carbonate, ΔR, Sea level change, Paleoenvironment, South Pacific, Stable oxygen isotope

