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Isotopic composition of *Conomurex fasciatus* shells as an environmental proxy for the Red Sea

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ABSTRACT

The marine gastropod *Conomurex fasciatus* (Born 1778) is the main component of thousands of shell middens on the Farasan Islands in the southern Red Sea. The middens date from 6500 to 4500 cal BP and cover the period of increased aridification over the region. No general research on *C. fasciatus* has been carried out before and basic information about the species is mostly speculative. To test if *C. fasciatus* shells can be used as a recorder of climate variability, we collected living specimens from the Farasan Islands, in Saudi Arabia, over a 1.5 year period. This area receives almost no precipitation and sea surface salinity is extremely high (38–39 psu), and sea surface temperature (SST) ranges from +26.5 °C to +34.9 °C.

Raman spectroscopy results on modern *C. fasciatus* shell samples show these specimens to be aragonitic. Ground fragments from archaeological *C. fasciatus* shells used for isotope analyses were also measured by Raman spectroscopy and shown to be well preserved against diagenetic alterations leading to aragonite to calcite transformation. Measured shell-edge $\delta^{18}\text{O}$ values range from -0.5% to -1.7% . Calculated modern shell edge temperatures from these $\delta^{18}\text{O}$ values correlate with modern SST measured on site with an error of ± 2.4 °C. Two different growth rates occurred in the shells of *C. fasciatus*. The measurement of growth increments in the lip part of adult specimens indicates a tide-related growth rate of ~ 13 mm/year. Sequential $\delta^{18}\text{O}$ data from juvenile parts of the shell indicates a faster growth rate of ~ 90 mm/year. This growth rate and the correlation of $\delta^{18}\text{O}$ with measured temperatures allows the use of *C. fasciatus* shell $\delta^{18}\text{O}$ as a palaeoclimate proxy.

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1. Introduction

The Farasan Island shell middens in the southern Red Sea suggest intense coastal shellfish exploitation (Alsharekh and Bailey, 2014; Bailey et al., 2007, 2013). With over 3000 recorded shell middens, they represent some of the densest accumulations of coastal middens in the world (Fig. 1). The middens are exceptional, especially when compared to the small number of prehistoric coastal sites on the Arabian mainland located 40 km farther east (Durrani, 2005).

The Farasan middens accumulated over a period from 6500 to c. 4500 cal BP (Bailey et al., 2013). The changing distribution of sites suggests a rapid change in sea level, in the overall environment, as well as in exploitation intensity (Meredith-Williams et al., 2014a). The time frame of exploitation partially covers climate change from a humid to more arid conditions during the mid-Holocene from around 7000 to 6000 cal BP (Adamson et al., 1980; Arz et al., 2003; Bar-Matthews et al., 1999; van Campo et al., 1982; Fleitmann et al., 2007; Gasse, 2000; Hoelzmann et al., 1998; Pachur and Kröpelin, 1987; Rossignol-Strick, 1983, 1985). Humid conditions are associated with a northward displacement of the summer monsoon due to a shift in the intertropical convergence zone (ITCZ) to 23°N (Biton et al., 2010). After c. 6000 cal BP, it is thought that conditions were more arid, possibly as a result of ITCZ moving southward

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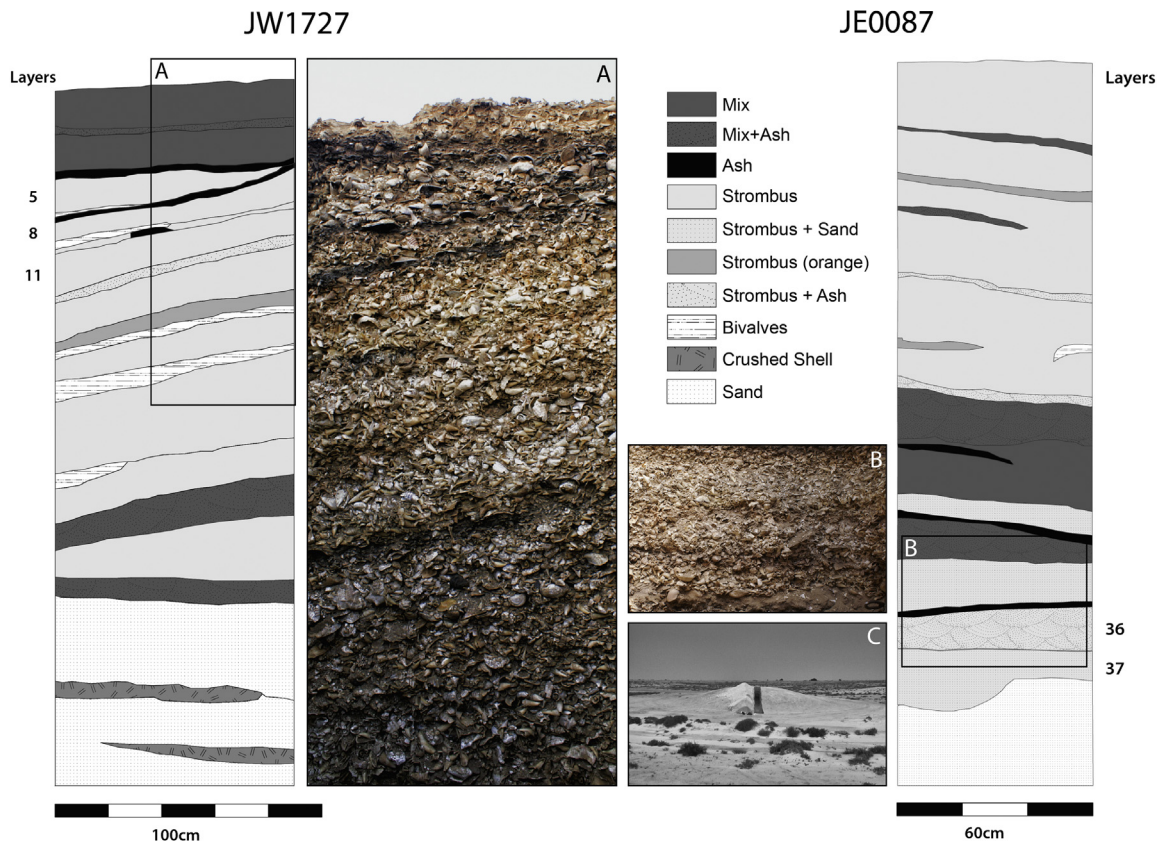
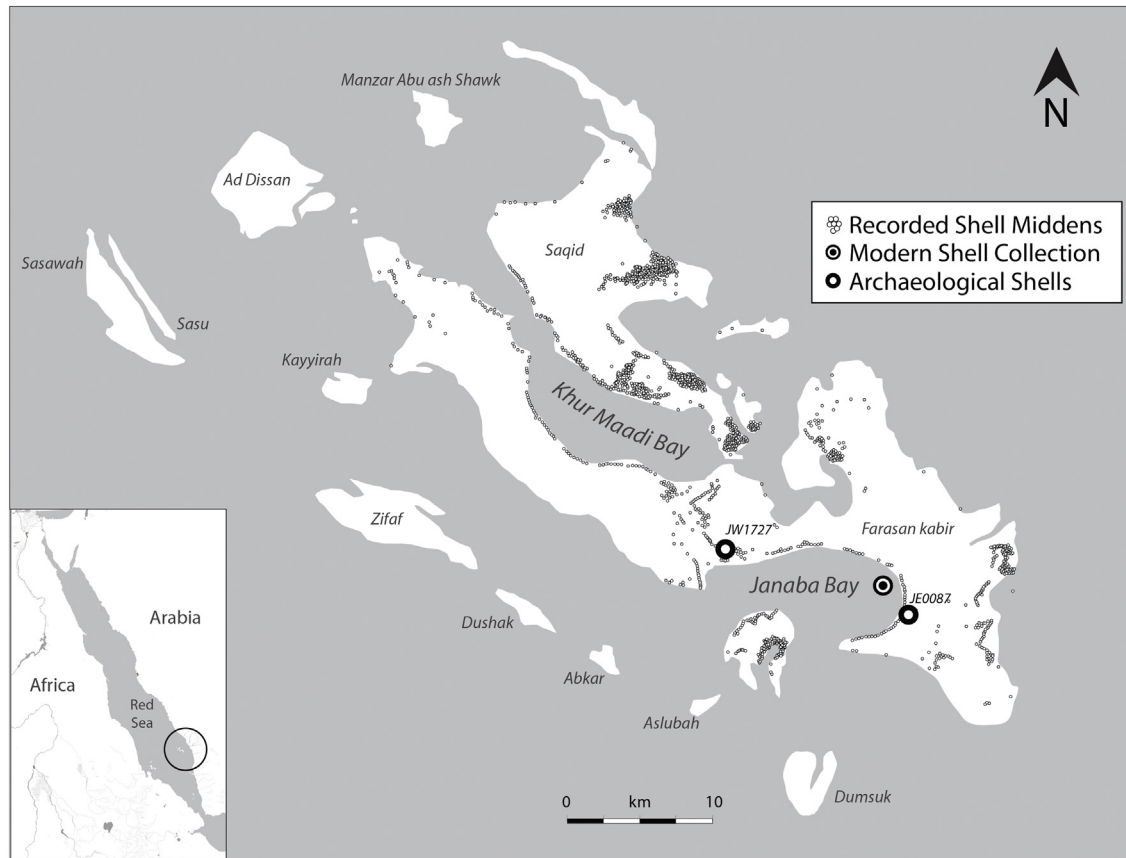


Fig. 1. Study area and overview of shell midden cluster on the Farasan Archipelago, southern Red Sea. Panels A and B show stratigraphic context of archaeological samples. Panel C shows site JE0087 and location of trench.

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