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Inferring seawater temperature over the past 2,500 years in the Southern California Bight on the basis of brachiopods

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Use of calcite δ18O in brachiopod shells in assessing past variations in seawater temperature remains poorly constrained in the absence of other methods due to vital effects and unknown variations in seawater density, salinity. Here, in order to evaluate past changes in seawater temperature of mainland shelf habitats off the Southern California Bight over the past 2,500 years, we analyze δ18O and Mg/Ca ratio of dead shells of the terebratulid brachiopod Laqueus erythraeus collected at 60-80 m water depths and age-dated by radiocarbon-calibrated amino acid racemization. These dead Holocene shells show excellent preservation (Mn concentrations < 10 ppm and Sr concentrations above 800 ppm). Although historical changes in sea-surface temperature in the southern California Bight were inferred on the basis of alkenones and δ18O in of planktonic foraminifers, temperature history of deeper shelf below storm wave base in this region remains unclear.
First, we investigate thermal sensitivity of Mg/Ca ratio (using Laser Ablation Inductively Coupled Plasma Mass Spectrometry and wavelength-dispersive spectrometry) in the terebratulid brachiopod Laqueus erythraeus (collected in 1994 at Santa Catalina Island at 116 m water depth). At this depth, annual temperature range is relatively small (between 9-11ºC), although at times of El Nino events in 1982-1983, 1986-1987, and 1992-1993, monthly temperature attained 13 ºC. We find that δ18O measured along a growth profile of a shell precipitated in oxygen isotopic equilibrium with ambient seawater, and maxima in Mg/Ca ratio coincide with minima in δ18O, suggesting that fluctuations in Mg/Ca ratio trace temperature fluctuations, as observed also in other brachiopod species. Second, preliminary observations of Holocene shells show that Mg/Ca ratios show centennial-scale fluctuations but on average remain remarkably constant, with minima and maxima staying within intra-shell seasonal variations captured by extant specimens collected in the 20th century. δ18O values over the past 2,500 years also remain within bounds of values in shells collected in the late 20th century, although mean values are on average heavier.