

Spatiotemporal Variability of Foraminifera off the Coast of San Diego

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INTRODUCTION

- Foraminifera are protists with tests made of CaCO_3 or organic material
- Foraminifera are useful bioindicators for past climates (Dong et al., 2019)
 - Highly sensitive to environmental change
 - Fossil preservation in sediment
- Water depth affects pressure, temperature, and dissolved oxygen (DO)
 - Affects zonation of benthic foraminifera (Lavin et al., 2002)
- Increasing ocean temperature decreases DO concentrations (Breitburg et al., 2018)
- California Continental Borderland (CCB)
 - Coastal upwelling
 - Input of terrigenous organic matter
 - High productivity/strong OMZ
- Research Objective:** Characterize foraminiferal assemblages on shelves 100–300 m deep on the CCB to examine variability with water depth and dissolved oxygen over an 11-year time series and related to the El Niño and the Southern Oscillation (ENSO) cycles

METHODS

Location and Field Methods

- Annual research cruises offshore of San Diego
 - September (2001–2011)
- Three different water depths
 - 100 m, 200 m, 300 m (Figure 1)
- Sediment samples (0–5 cm)
 - Multicore (Figure 1)
- Water depth and DO
 - CTD
 - Oxygen probe

Lab Methods

- Split core samples
 - micro-splittter
- Sorted and glued samples
 - 110–150 and 150–300 μm
- Counted and analyzed foraminifera
 - 300 specimens counted per station
- Spearman's rank correlation coefficient
 - Analysis of foraminifera abundance vs. water depth and DO

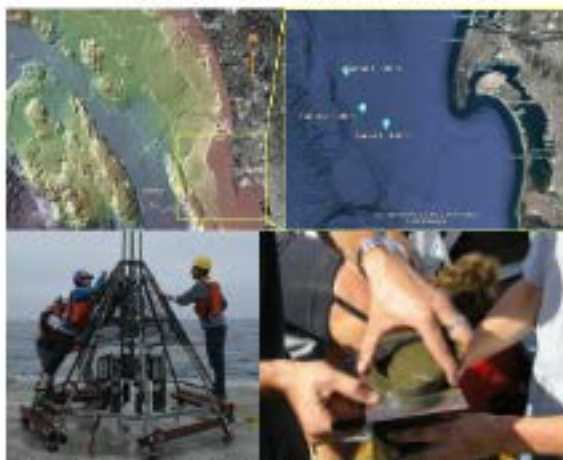


Fig. 1 Sample sites (top), multicore (bottom left), slicing up the cores (bottom right)

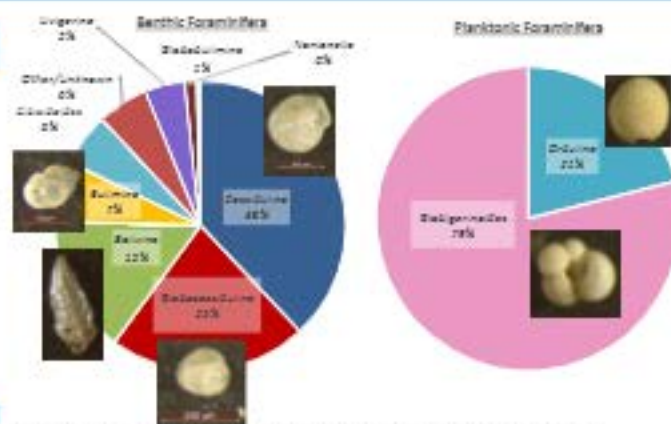


Fig. 2 Total relative abundance of benthic foraminifera (left) and planktonic foraminifera (right)

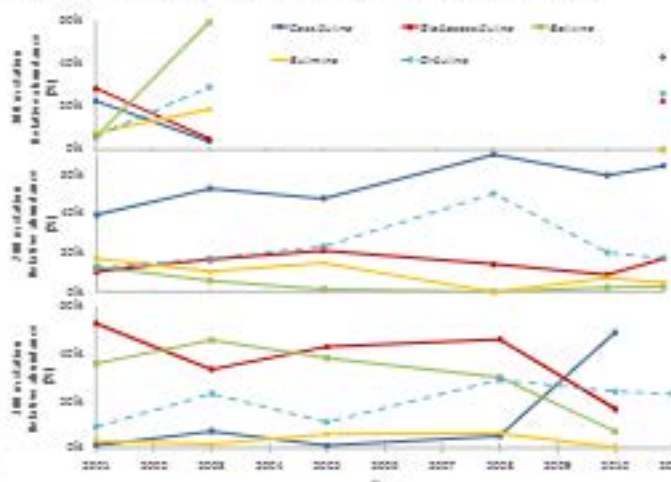


Fig. 3 Relative abundance of top four most abundant benthic foraminifera species Globobulimina, Globobulimina, Bulimina, and Globobulimina per station over time (thicker lines)

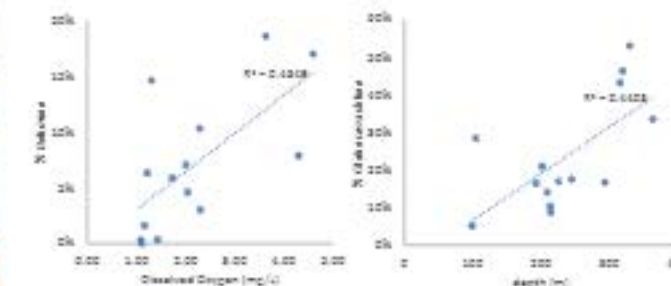


Fig. 4 Correlation analysis between dissolved oxygen and Bulimina and water depth and Globobulimina

RESULTS

- Top three most abundant benthic foraminifera across all stations and years are Globobulimina, Globobulimina, and Bulimina (Figure 2)
- Most abundant planktonic foraminifera across all stations and years is Globobulimina (Figure 2)
- Spatial Variability**
 - Globobulimina more abundant at shallow stations, less abundant in deeper stations
 - Relative abundance of Globobulimina increased significantly with water depth ($R^2 = 0.4308$, $p = 0.002$, $\rho = 0.66$) while the abundance of Bulimina decreased significantly with water depth ($R^2 = 0.4308$, $p = 0.002$, $\rho = -0.66$) (Figure 4)
 - Mean dissolved oxygen values decreased with depth (100 m = 2.22 mg L^{-1} ; 200 m = 2.12 mg L^{-1} ; 300 m = 1.90 mg L^{-1}) (Figure 4)
 - A significant relationship between dissolved oxygen and foraminifera was only found for Bulimina ($R^2 = 0.4308$, $p = 0.001$, $\rho = 0.70$)

Temporal Variability

- Constant composition of benthic foraminifera from 2001–2008 (Figure 3)
- Increase in Globobulimina abundance in deeper station in 2010 (Figure 3)
- No secular change in planktonic foraminifera related to ENSO

DISCUSSION

- Upper sediment mixing could potentially explain 2010 shift in 300 m station
- Globobulimina – increased abundance with depth (Palmer et al., 2000); found in anoxic sediment (Bernard, 1988)
 - Found in higher abundance in the more oxic 100 m samples
- Globobulimina – oxic indicator species (Palmer et al., 2000); found in anoxic sediment (Bernard, 1988)
 - Found in higher abundance in the more hypoxic 300 m samples
- Bulimina – hypoxic indicator species (Palmer et al., 2000); “high productivity” taxon (Panchang et al., 2006)
 - Found in higher abundance in the more hypoxic 300 m samples
 - Bulimina – “high productivity” taxon (Vardelli et al., 2014)
 - Found in low relative abundance in both the 100 and 300 m samples
- My research helped increase understanding of the relationship between foraminifera assemblages and past environments
- A larger time interval is needed to analyze long-term changes in foraminiferal community composition in relation to climate changes
- Future direction
 - Additional research analyses data from 2001–2011
 - Continuing this research in diverse environments is crucial to a deeper understanding of past and future climates

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