A Several-Century Record of Low-Oxygen Conditions on the Louisiana Continental Shelf

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Hypoxia occurs in continental-shelf subsurface waters when the uptake of oxygen by respiration exceeds its resupply. Measurements of Louisiana continental-shelf waters have indicated that hypoxia (oxygen content <2mg/L) has increased since 1985 (Rabalais et al., 1999). Sediment cores taken from the Louisiana shelf have provided a record of hypoxic and low-oxygen conditions over longer time intervals of 50-100 years (Sen Gupta et al., 1996; Blackwelder et al., 1996; Osterman et al., 2005).

Our previous work established the use of the relative abundance of three low-oxygen-tolerant benthic foraminifers (*Pseudononion atlanticum, Epistominella vitrea,* and *Buliminella morgani*) as a proxy for the present hypoxic conditions on the Louisiana shelf (Osterman, 2003). This proxy, named the PEB index, can be used in sediment cores to document low-oxygen conditions. The analysis of the PEB index in four sediment cores provided evidence for low-oxygen events that pre-date the start of extensive use of commercial fertilizer in the Mississippi Basin (~1950). Fluctuations in the amount of these low-oxygen-tolerant species between 1817 A.D. and 1910 A.D. correspond with increased discharge/flooding events in the Mississippi River drainage. In most cases, high river discharge correlates with high percentage values of the low-oxygen-tolerant PEB species (Osterman et al., 2005).

The results from the newly analyzed lower section of Louisiana shelf core PE0305-GC1 (60-164 cm) indicate that the percent of the low-oxygen-tolerant species records significant fluctuations of bottom-water oxygen in the past. At times, the PEB values in the lower core exceed the values that are found in the upper fertilizer-driven hypoxia interval (post 1900). Using a sedimentation rate extrapolated from ^{210}Pb data in the top 20 cm, low-oxygen events may extend back to ~1500 A.D.

In addition, analyses of carbon stable-isotope compositions of sedimentary organic matter have also been completed for core PE0305-GC1. In the upper 100 cm of the core, negative excursions in % δ^{13}C generally correspond to increases in PEB. The very negative values of % δ^{13}C (<-28) found in the core record most likely represent incorporation of biomass from anerobic microbial recycling communities to the bulk sediment and support the interpretation that high PEB values represent low-oxygen bottom-water conditions. Below 100 cm core depth, the correspondence of % δ^{13}C and PEB is more variable. Sampling for carbon-isotope analyses and foraminifer census was done at different times. Thus, the offset in isotope and foraminifer records in deeper levels of the core could be caused by offsets in sampling levels.

These preliminary results show a correlation between geochemical proxies and benthic foraminifers. Abundance fluctuations in low-oxygen-tolerant benthic foraminifers, supported in part by % δ^{13}C data, indicate low-oxygen bottom-water events have developed periodically on the Louisiana shelf for approximately the last 400 years. The foraminifer data indicate that low-oxygen conditions near the Mississippi Delta, as severe as conditions associated with hypoxia events of the last 50 years, occurred in the 1700s. Our preliminary results suggest that development of low-oxygen bottom waters is a complex natural process that has been altered by human activities.

References

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