Seasonal oscillations in microbial iron and sulfate reduction in saltmarsh sediments

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Seasonal oscillations in heterotrophic microbial community structure at three saltmarsh sites on Sapelo Island, GA, USA were measured using culture enumerations for anaerobic Fe(III)- and Mn(IV)-reducing bacteria (FeRB and MnRB) and 16S rRNA probes targeted for sulfate-reducing bacteria (SRB). The observed seasonal trends are not identical for all microbial populations. Rather, at all sites, sulfate reduction rates (Kostka et al., 2002) and MnRB populations peak in summer, while FeRB populations collapse during summer .

Seasonal oscillations in SRR and MnRB populations trend closely with seasonal changes in temperature and aboveground live biomass in the saltmarsh, suggesting that these populations, unlike FeRB, are limited primarily by labile organic carbon availability and temperature. The collapse in FeRB populations during summer is consistent with limitation of FeRB by SRB, specifically, via production of sulfide that abiotically reduces available Fe(III) oxides.

The dependence of FeRB populations on sulfide producion was further investigated using sediment slurry batch incubations. Increased temperature and increased availability of labile organic carbon led to increased SRR and to more rapid declines in culturable anaerobic FeRB populations. However, no decline in FeRB was observed with increased temperature when SRB were inhibited by addition of molybdate. Addition of sulfide with or without molybdate depressed populations of FeRB at all temperatures relative to no sulfide controls. Both the field and laboratory data are consistent with an iron reduction mechanism that shifts seasonally between periods of high sulfate reducing activity corresponding to periods of primarily chemical reduction of Fe(III) oxides by sulfide, and by periods of low sulfate-reducing activity when Fe(III) oxides are available for biotic reduction by FeRB.

Kostka J.E., Roychoudhury A. and Van Cappellen P. (2002), *Biogeochemistry*, in press.

$\delta^{18}O$ of Permian and Triassic brachiopods: implications for coeval seawater and paleotemperatures

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A reconnaissance study of Permian and Triassic brachiopods from the Tethyan realm and the Germanic Basin yields a range of oxygen isotope values that may ultimately provide constraints for coeval seawater temperatures.

The $\delta^{18}O$ of the Middle and Upper Triassic Tethyan brachiopods varies from -0.6 to -3.5 ‰ (VPDB). Some of these coexisted with reef-building corals that require permanent water temperatures of 18 to 32°C. Assuming 0 ‰ (VSMOW) for coeval seawater these Tethyan brachiopods would yield a comparable temperature range.

For Permian samples, the situation is more complex due to the large latitudinal variability of the studied specimens. The Dzhulfian (Upper Permian) $\delta^{18}O$ from the equatorial Tethyan Jolfa section in Iran scatter between -2.4 and -4.3 ‰ VPDB. The calculated paleotemperatures, assuming a seawater $\delta^{18}O$ of 0 ‰ VSMOW, would be ~ 26 to 36 °C, an unlikely outcome considering that the confining sediments were deposited at a depth in excess of 100 m. Assuming -2 ‰ for $\delta^{18}O$ VSMOW for the Upper Permian seawater would yield more realistic paleotemperatures of ~ 18 to 26°C.

The high latitude Asselian and Artinskian (Lower Permian) Cis-Uralian samples yielded $\delta^{18}O$ of -1 to -3.4 ‰ VPDB, becoming more negative with decreasing age. This is consistent with the advancing deglaciation of the Gondwana. Assuming -1 ‰ and -2 ‰ VSMOW for the glacial and ice-free intervals, respectively, the seawater paleotemperatures would range between 12 and 22°C.

For the Germanic Basin, the lower Zechstein (Upper Permian) brachiopods are enriched in ^{18}O, with $\delta^{18}O$ from -1.2 to 2.5 ‰ VPDB. One alternative could relate these high isotope values to influx of cold waters into the Germanic Basin from the northern Boreal Ocean. However, evaporitic sediments in the basin argue against such an interpretation, suggesting that high evaporation rates caused the coeval seawater to be impoverished in ^{16}O.

The brachiopods from the Germanic Middle Triassic Muschelkalk Sea, on the other hand, have $\delta^{18}O$ of -2 to -6 ‰ VPDB, values that are difficult to explain as due solely to temperature effects. At these times, the connection between the Germanic Basin and the Tethyan Ocean in the south was often restricted or totally interrupted. Considerable influx of light meteoric water may have influenced the $\delta^{18}O$ values of the seawater.