

REDOX CONTROLS ON NUTRIENT REGENERATION DURING ORGANIC MATTER DECOMPOSITION IN THE ORCA BASIN, GULF OF MEXICO

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Controls on N and P regeneration during organic matter (OM) decomposition, particularly the effects of oxygenation, remain a topic of debate. It has alternately been argued that: there is no preferential regeneration of either N or P relative to C under normal marine (i.e., oxic) conditions (Anderson and Sarmiento 1994); N is preferentially released under oscillating redox conditions (Aller, 1994); and P is preferentially released under anoxic conditions (Ingall and Jahnke, 1997). Upon release, remineralized nutrients can be retained in sediments or can diffuse from sediments, making them available for biological utilization and thereby increasing primary productivity and the potential delivery of OM to the sediments.

To address these questions, four sediment cores were taken from the Orca Basin in 2003 under different depositional regimes, oxic, oscillating, transitional, and anoxic. The Orca basin is a small (~400 km²), hypersaline, anoxic/sulfidic basin on the northwest slope of the Gulf of Mexico, located ~290 km south of the Mississippi delta. The fact that the Orca Basin is small, deep (1800 to 2400 m) and at the distal end of the continental slope, means that all parts of the basin (anoxic depocenter, oxic periphery, transitional saddle and outer rim) receive the same influx of OM, both in type (aquatic vs. terrestrial) and amount. Thus, the only factors that differ between the various cores are redox state and salinity.

Analysis to date has focused on measurements of total organic carbon and total nitrogen, and has yielded interesting results, particularly when compared to preliminary data from cores taken in 1997. In both years, the oxic and anoxic cores display very similar trends, with the TOC values ranging from 0-1% and 1.5 – 2%, respectively. In contrast, the transition cores are markedly different, ranging from 0.5 to 1.75% TOC. The blackest parts of the transition cores, indicating more anoxic conditions, have similar TOC contents to the anoxic cores, whereas the light, homogeneous brown sections have TOC contents similar to the oxic cores. Red sections of the transition cores are associated with a wide variety of %TOC values.

In 1997, we measured the ratio of organic C to organic nitrogen (C_{org}/N_{org}) of these oxic, anoxic, and transitional sediment cores. We found that the transitional core had significantly elevated C_{org}/N_{org} values that were 2x-3x those of the oxic and anoxic cores, which were near Redfield values (~8-10). In contrast, in 2003 we measured the ratio of

organic C to total N (C_{org}/N_{total}). These total N values include both organic N and inorganic N, most likely in the form of NH_3 either in pore waters or adsorbed onto clay minerals. Here, we found that both the transition and oxic cores had values in the ~8-10 range, whereas the anoxic cores had values that were 2x-3x lower than the other cores, and much more variable.

These results suggest a number of possible interpretations related to the effects of oxygen content on OM remineralization and subsequent nutrient regeneration. The TOC% is as expected, least under anoxic conditions, greatest under oxic conditions, with the transition zones intermediate. C/N values, however, raise several interesting questions. Low C_{org}/N_{total} and high C_{org}/N_{org} in the '03 and '97 transition cores, respectively, indicate impacts of oxygen regime on OM remineralization. The high C_{org}/N_{org} values in the '97 core indicate preferential release of N_{org} from OM during decay. However, the comparatively lower C_{org}/N_{total} values in the '03 core (statistically the same as the oxic and anoxic cores) indicate that the N_{org} released remains sequestered in the sediments as N_{inorg} , and is therefore not released to bottom waters. Continuing analyses will produce a more directly comparable dataset by analyzing C_{org}/N_{org} data for the '3 cores, as well as producing a P record to compare between the various sites.

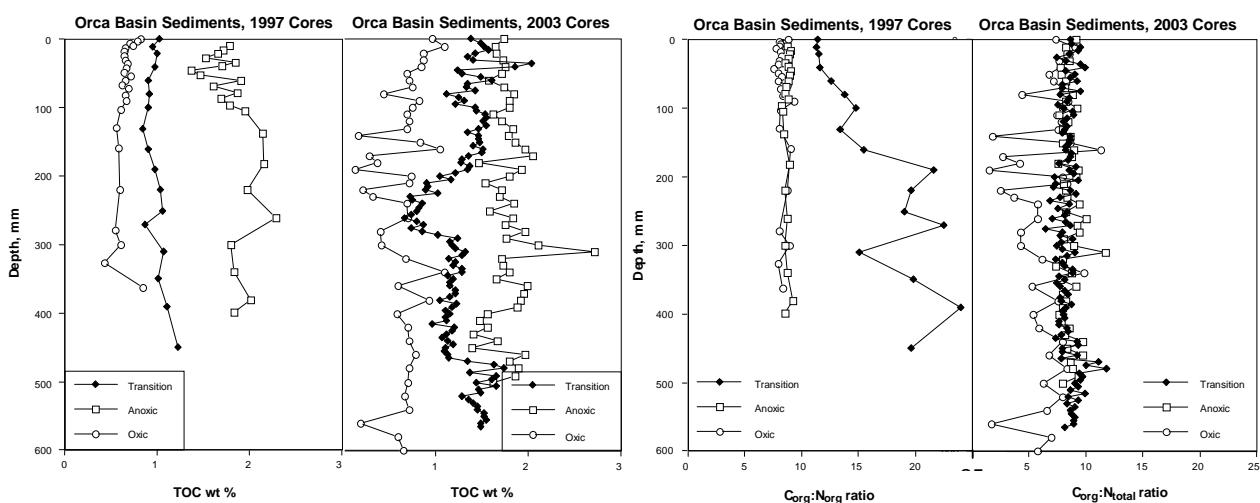


Figure 1. Organic carbon weight percent, and C/N ratios from Orca Basin 1997 and 2003 cores. Note that '97 cores are C_{org}/N_{org} and '03 cores are C_{org}/N_{total} .

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