Goldschmidt 2024 Abstract
https://doi.org/10.46247/gold2024.22599

Impact of water column hypoxia on the pathways of organic carbon mineralization and resultant Fe-Mn-S-P cycles in coastal sediments

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More than 500 coastal sites have been reported as hypoxic condition with the concentrations of dissolved oxygen (DO) less than 63 μM or 2 mg L^{-1}. Biogeochemical processes associated with the organic carbon (C_{org}) mineralization in organic-rich coastal sediments greatly control the dynamics of various elements in the sediment-water interface. Many biogeochemical studies have revealed various factors such as bioturbation, vegetation and tidal flushing that control the rates and pathways of C_{org} mineralization. However, little has been conducted on the impact of water-column hypoxia on the pathways of C_{org} mineralization and resulting element cycles in coastal sediments. We investigated changes in major C_{org} mineralization pathways (i.e., reduction of manganese, iron and sulfate) and resulting S-Fe-Mn-P cycles at two sediments sites: (1) the JD site with severe hypoxia (DO: 5.94 μM) and low Mn content (< 5.80 μmol g^{-1}) and (2) the CB site characterized by mild hypoxic condition (DO: 93.1 μM) and high Mn content (max. 114 μmol g^{-1}) associated with the intensity of hypoxia in the water column in Jinhae Bay, a eutrophic coastal ocean with recurring seasonal hypoxia in Korea. At JD site, the sulfate reduction rates (SRR) rapidly increased during hypoxia, and remained high even after re-oxygenation of the bottom water. As the results of the active S cycle, the PO_4^{3-}, HS^-, and FeS were accumulated in sediments, whereas the Fe-oxides were decreased. On the other hand, in the CB site, C_{org} mineralization during pre-hypoxia was dominated by MnR and by FeR, whereas the FeR and SR dominated C_{org} mineralization during hypoxia condition. Abiotic MnR coupled to the reoxidation of sulfide and Fe^{2+} resulted in an accumulation of dissolved Mn in the surface sediments. Difference in hypoxia intensity was responsible for a distinct distribution pattern in Fe(Mn)-bound P. At CB site, Fe(Mn)-bound P decreased about two-fold during hypoxia, and then increased again. Meanwhile, at JD site, Fe(Mn)-bound P decreased about four-fold during hypoxia, and remained low thereafter. Our results demonstrate that the intensity of water-column hypoxia has a significant impact on change in C_{org} mineralization pathways and biogeochemical cycles of Fe-Mn-S-P.