Sulfur and carbon cycling in Fe dominated sediments from the Mozambique margin: Past and current processes

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Deltaic margins at the outlets of the world's major rivers provide a highly dynamic sedimentary environment and are thus key areas in global biogeochemical cycles.
The upper slope of the Mozambique margin is the largest river-fed deposition center along the Eastern African Margin. The tropical catchment area of the Zambezi River provides sediments rich in organic material as well as iron oxides. In response to global sea level rise at the last glacial-interglacial transition, drill sites along the shelf break of the Mozambique margin experienced order-of-magnitude declines in sedimentation rates. Earlier work (März et al., 2008, 2018) has shown that this change affected the diagenetic processes and resulted in non-steady state conditions over prolonged timescales.
We present new geochemical data from two sediment cores acquired in 2015 during the PAMELA-MOZ4 campaign onboard R/V Pourquoi Pas? offshore Mozambique. Both sites exhibit shallow sulfate-methane transition zones (SMTZs) 5 to 10 m below seafloor and feature pore-waters with elevated Fe^{2+} concentrations and no free H_2S. To identify the dominant early diagenetic processes giving rise to these observations, we constructed a reaction transport model and simulate the diagenetic evolution at both sites over the past ~20 to 30 ka. We assess the contribution and turnover of land-derived organic material over time, and identify the factors that lead to a lock-in of the sulfate-methane transition zones in discrete sediment intervals, leading to the enrichment of authigenic minerals in these zones. We show how the present-day system is influenced by higher methane production in the past and assess the processes that are currently keeping pore-waters ferruginous, rather than sulfidic.
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