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Authigenic pyrite formation in iron-dominated marine sediments of the Mozambique Margin

Mark Zindorf[1], Jurjen Rooze[2], Christof Meile[2], Gwenael Jouet[3], Christian März[4], Robert Newton[4], Olivier Rouxel[3], Ewan Pelleter[3], Christophe Brandily[1], Nicolas Gayet[1], and Lucie Pastor[1]

[1]Laboratoire Environnement Profond, Ifremer - Centre de Bretagne, 29280 Plouzané, France (mark.zindorf@ifremer.fr)
[2]Department of Marine Sciences, The University of Georgia, Athens, GA 30602, USA
[3]Unité Géosciences Marines, Ifremer - Centre de Bretagne, 29280 Plouzané, France
[4]School of Earth and Environment, University of Leeds, Leeds LS2 9JT, UK

Sediment deposition along continental margins and especially close to the outlets of major river systems is highly dynamic and influenced by changing environmental conditions, such as sea-level variations and the shifting of ocean currents.
The upper slope of the Mozambique margin (SE Africa) receives its sediments from the Zambezi River and is the largest river-fed deposition center along the Eastern African Margin. Global sea level rise during the last glacial-Holocene transition led to a re-routing of the Zambezi River sediment plume. This caused order-of-magnitude changes in sedimentation rates along the shelf break of the Mozambique margin. The variable sediment input as well as changing organic matter load and quality resulted in non-steady state early diagenesis leading to changes in formation and upward flow of methane. This is reflected in temporally and spatially variable formation conditions of authigenic minerals (such as pyrite), especially at the sulfate-methane transition zone (SMTZ) where upward-diffusing methane is anaerobically oxidized by sulfate. Pyrite accumulations in sediment cores can be used to define the past positioning of SMTZs. The isotopic composition of sulfur in pyrite can provide information about the geochemical and environmental factors (e.g., availability of methane, sulfate, reactive iron) controlling the formation of these authigenic minerals during different times of sediment deposition.

We present geochemical data from sediment cores acquired in 2015 during the PAMELA-MOZ4 campaign onboard R/V Pourquoi Pas? offshore Mozambique. A reactive transport model is used to simulate the evolution of early diagenetic conditions over the time of sediment deposition (i.e., the last 27,000 years). By reproducing the currently observed mineral accumulations, the temporal development of methane generation and upward flux, and the past positioning of the SMTZ, can be reconstructed. With this, we are able to put a time constraint on past events of authigenic mineral accumulation and reveal their response to sedimentation rate changes caused by sea-level rise. We further discuss isotope signatures of small-scale diagenetic processes at the Mozambique margin.

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