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

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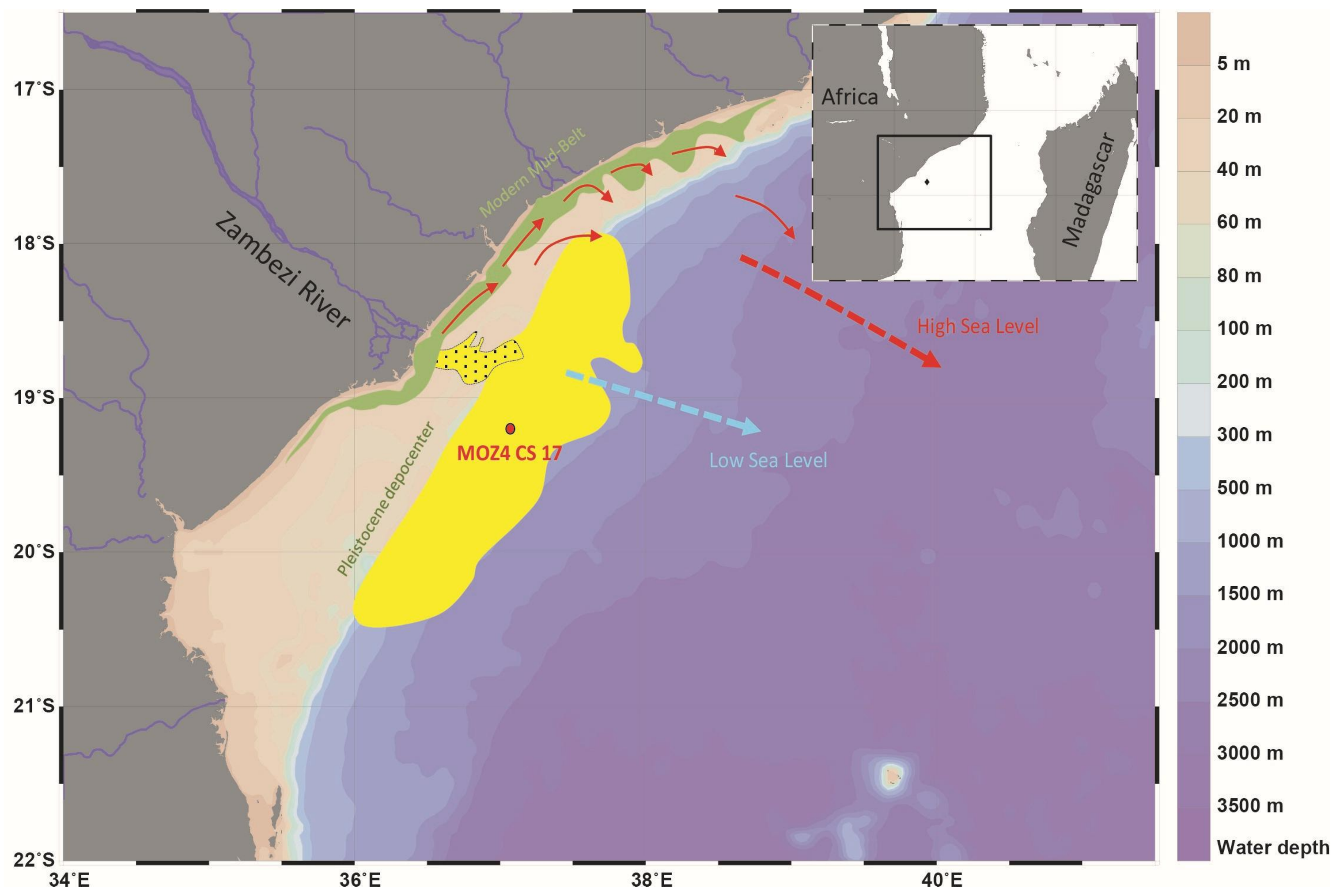


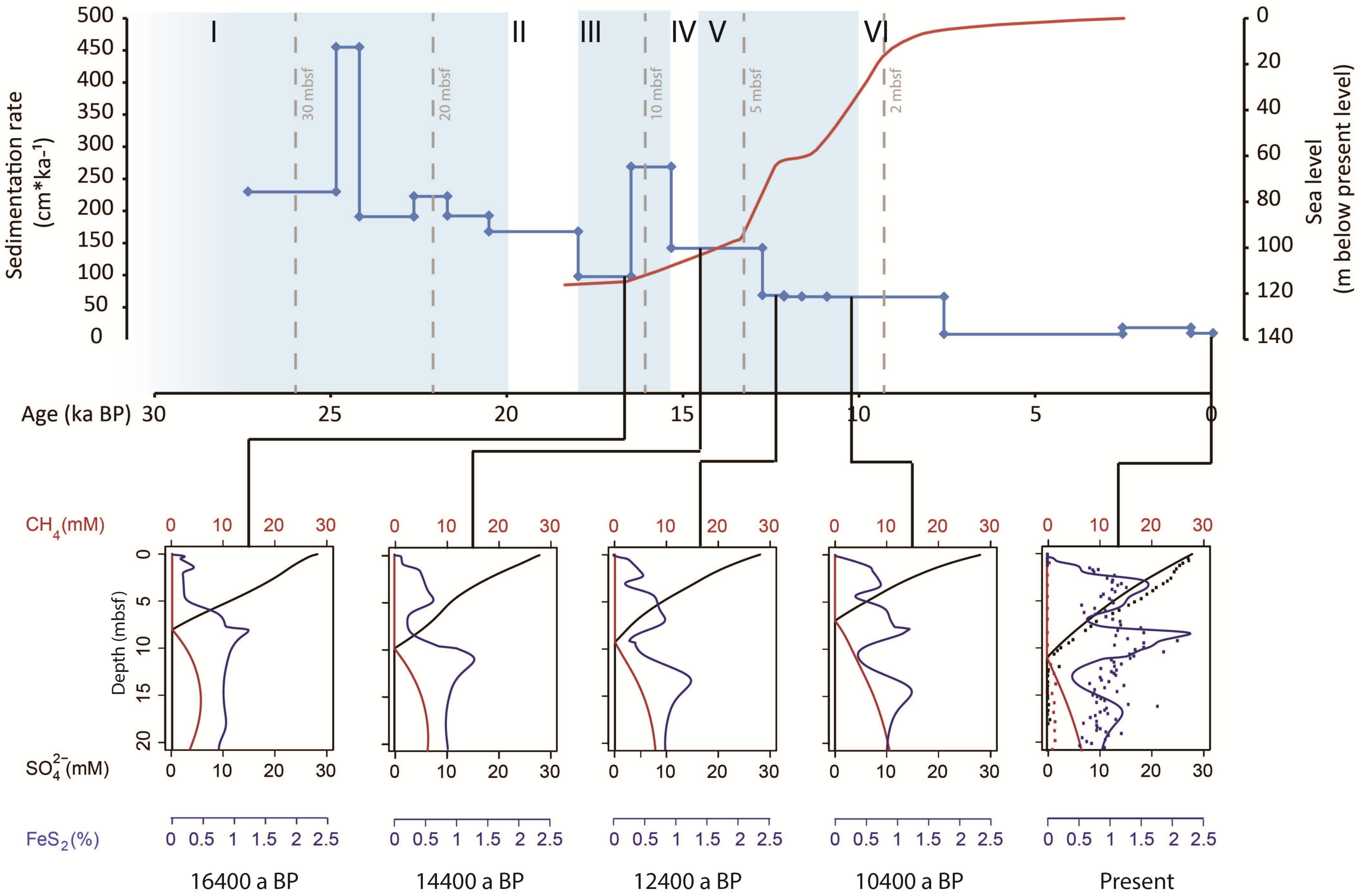
Area of Investigation: Red dot indicates position of Site CS17, blue arrow and yellow shading indicate Pleistocene sediment deposition, red arrow and green shade indicate modern sediment deposition. Map reproduced from [2] with ODV [3].

The Mozambique margin:

- Fed by sediments deposited by the Zambezi River
- During last glaciation sea level lowstand Zambezi sediments were deposited at the continental slope [1]
- After last deglacial sea level rise sediments deflected northwards -> decrease in sedimentation rates at continental slope [1]
- **Site CS17:** 550 m water depth, 35 m sediment core, 27.4 ka deposition history [2]

Project aims:

- Reconstruct carbon deposition and CH_4 generation over time
- Reconstruct past evolution of the sulfate methane transition zone (SMTZ)
- Understand influence of sedimentation rate changes on pyrite authigenesis and methanogenesis



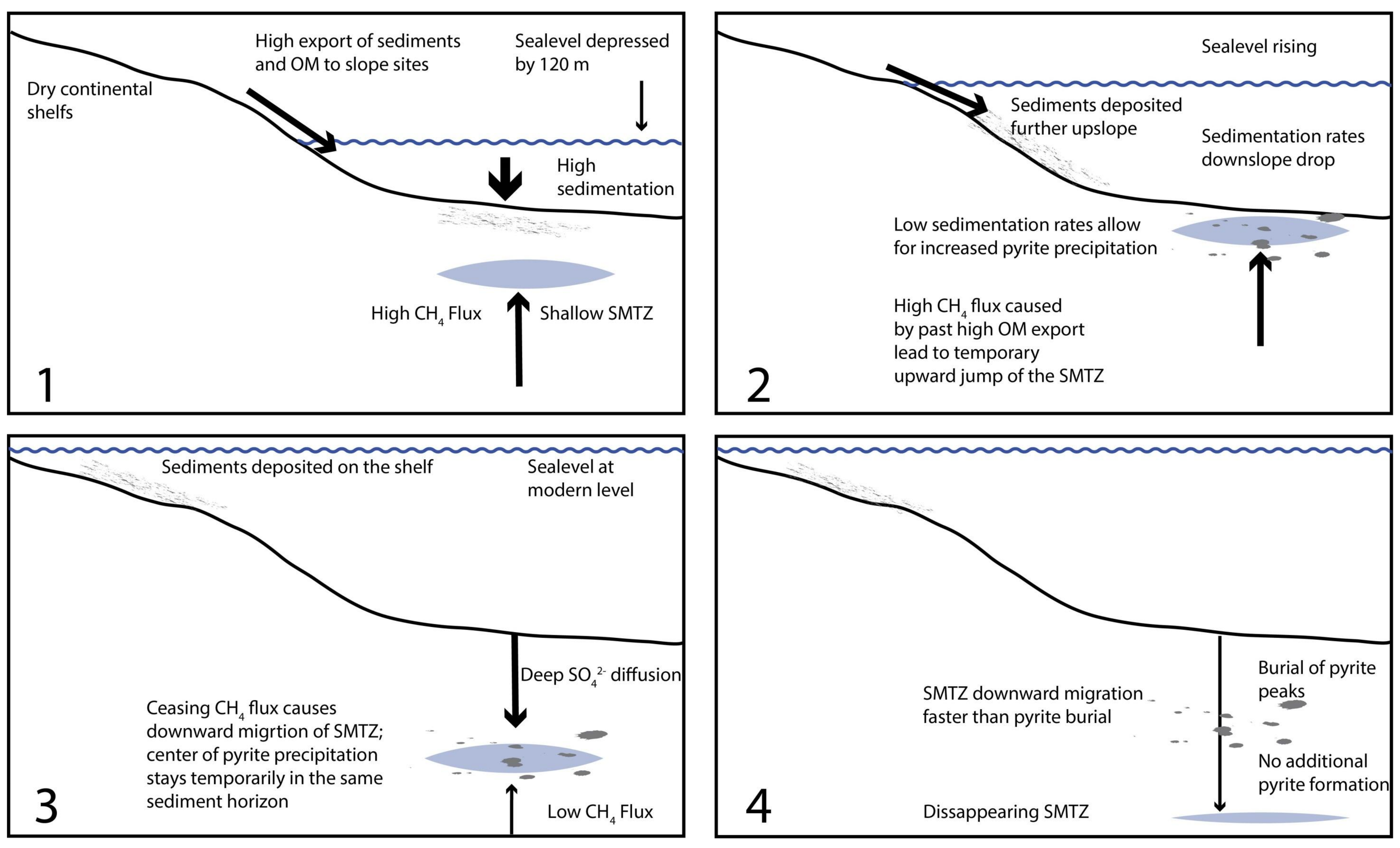
Development of diagenetic system: Upper panel shows evolution of sedimentation rate at Site CS17 over the last 27 ka BP (blue) and sea-level [4] (red). Lower panels show modelled diagenetic evolution of SO_4^{2-} (black), CH_4 (red) and pyrite (blue). Solid lines are modeled profiles, dots in right panel are measured data from sediment core.

Approach:

A 1D reactive-transport model is applied to simulate depth of sulfate-methane transition and ongoing pyrite precipitation. If authigenic pyrite accumulations observed in the sediment core at CS17 are reproduced by the model, it can be concluded that the model recreates past SMTZ behavior with sufficient accuracy.

Results and Discussion:

- At present, a pyrite peak in the SMTZ is found and a second pyrite peak around 15 m below sea floor (mbsf).
- In the past the SMTZ was mostly shallower than today.
- Three phases of low OM deposition had to be assumed to correctly reproduce pyrite peaks with the model (blue shaded areas in Figure left).
- Separation between pyrite peak in current SMTZ and the peak currently observed at 15 mbsf happened between 15 and 12 ka BP due to sudden increase and subsequent drop in sedimentation rates preceded by a phase of low OM deposition.
- Currently, SMTZ is moving downwards due to decreased CH_4 production.



Diagenetic evolution at the Mozambique margin can be expressed as a four-step conceptual model:

1. High sedimentation rates during last glacial cause shallow SMTZ and low pyrite accumulation.
2. Decreasing sedimentation rates allow for increased pyrite accumulation, high methane flux from below keeps SMTZ in shallow depth.
3. Decreasing CH4 flux leads to downward migration of SMTZ. Pyrite formation occurs in the same sediment interval, causing growth of pyrite peaks
4. SMTZ will subsequently move downwards faster, leaving substantial amounts of SMTZ-formed pyrite above (extrapolation into future).

Affiliations

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Literature

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[2] Jouet, G. and E. Deville (2015). "PAMELA-MOZ04 cruise, RV Pourquoi Pas?«
[3] Schlitzer (2015) Ocean Data View
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