Redox-dependent coupled cycling of iron and phosphorus on the dynamic Namibian continental shelf

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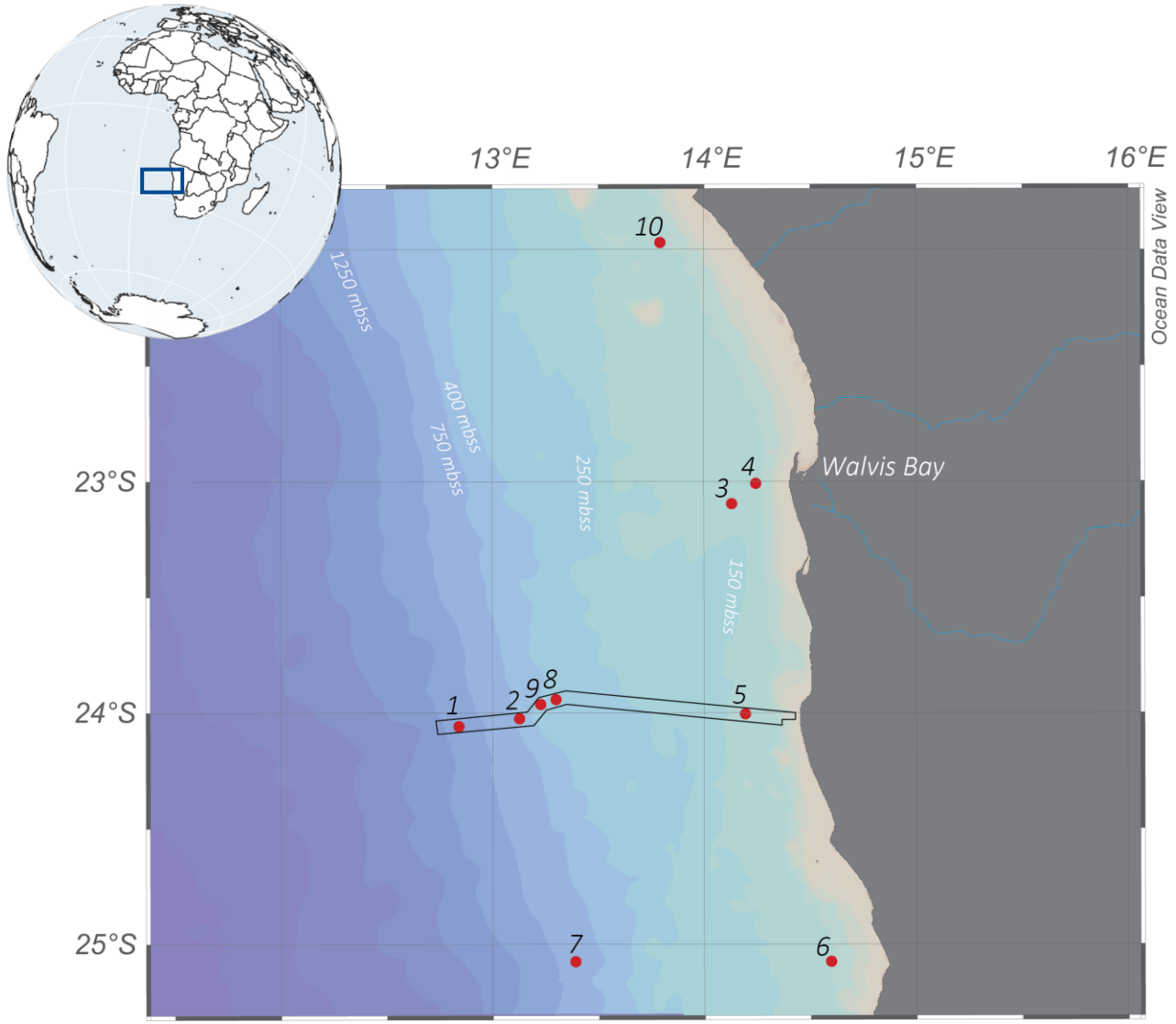
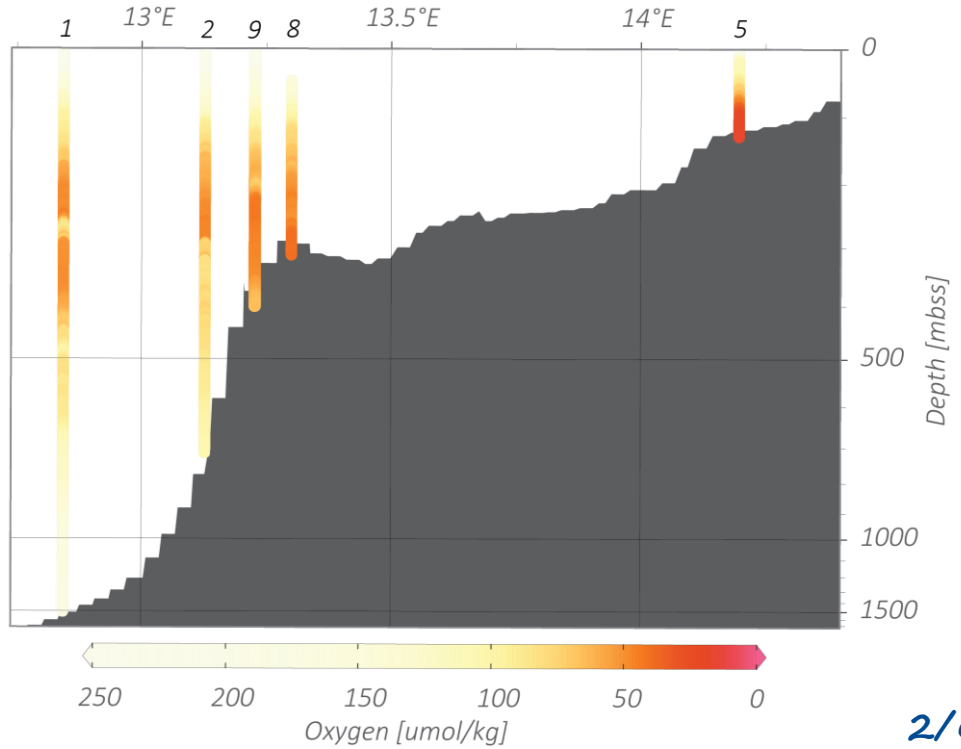
Benguela upwelling system

- One of the most productive regions of the world's oceans
- Upwelling deep waters provide nutrients to the shelf
- High rates of primary productivity in surface waters / organic matter remineralization at the sediment-water-interface
- Perennial oxygen minimum zone (OMZ) on the Namibian continental slope (down to ~ 50 µM O_2), seasonal anoxia on the shelf
- Dynamic depositional environment with off-shelf sediment redistribution





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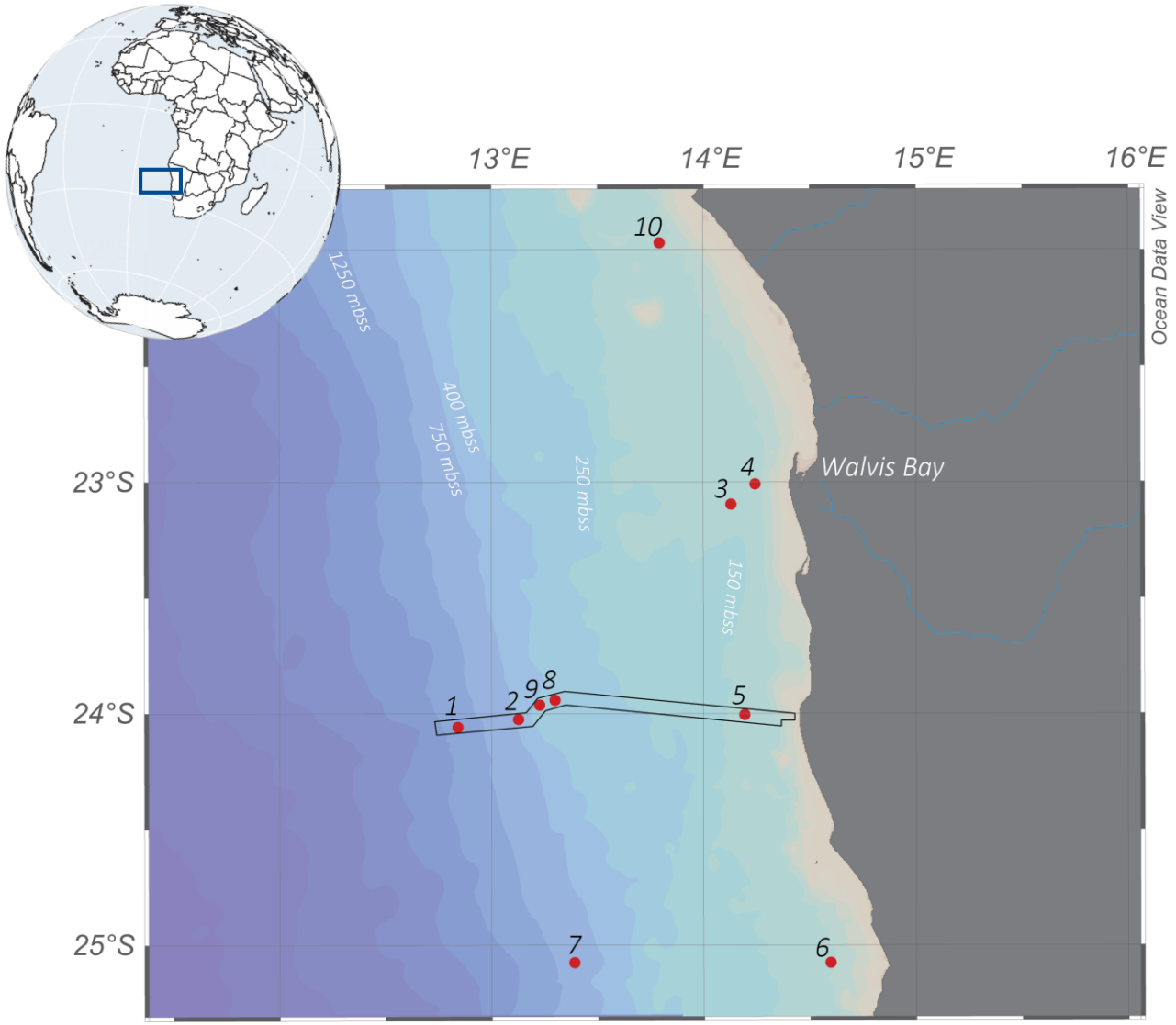


Aims of research

Our knowledge on the effect of such dynamic redox conditions on biogeochemical cycles of nutrients and trace metals remains incomplete. Here, we study:

(1) the intimate and complex coupling of bio-essential, redox-sensitive (trace) nutrients such as iron (Fe) and phosphorus (P)

(2) the role of microbes in mediating the sedimentary iron (Fe), phosphorus (P) and sulfur (S) cycles

(3) the impact of physical resuspension and redistribution on the shelf and slope

Sample collection

RV Pelagia, Jan 27 - Feb 14, 2019

cruise blog

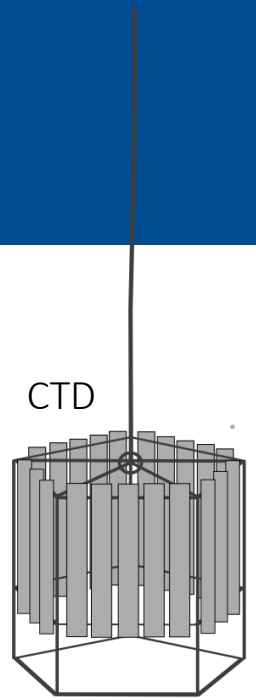
transects

>> North-to-South, along coastal mudbelt

>> East-to-West, from shelf (~100 mbss) to slope (~1500 mbss)

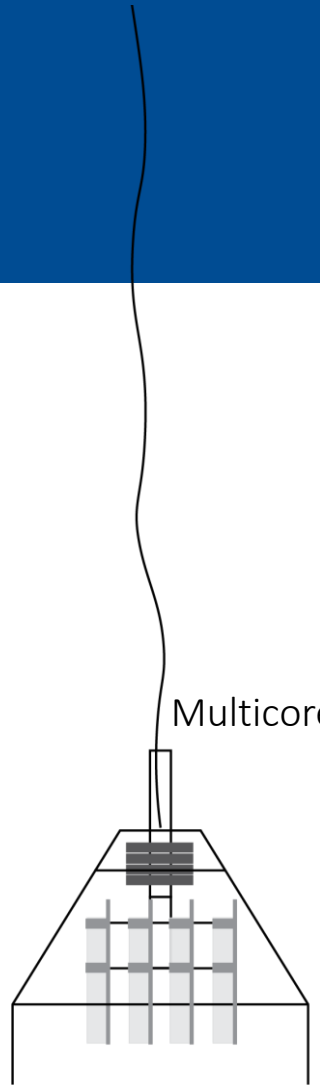
Sampling and analyses (all sampling under N_2 to avoid oxidation)

seawater* | suspended particulates | sediment and pore water*



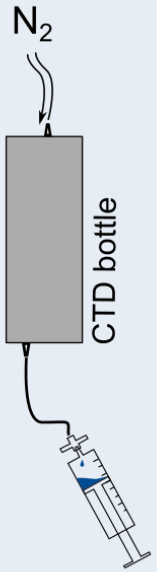
CTD

for sampling of dissolved and particulate phases in the water column

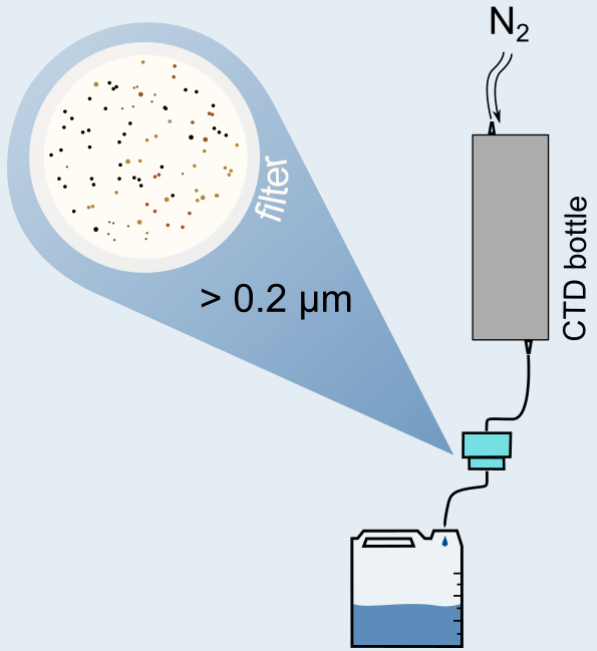


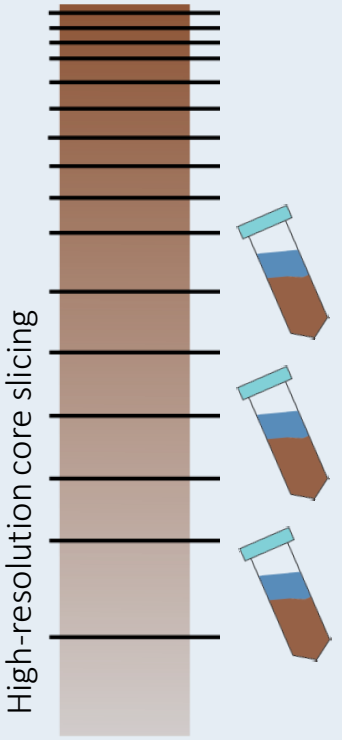
Multicorer

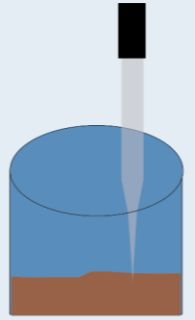
for sampling of surface sediments



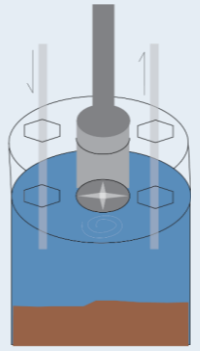
< 0.2 µm | unfiltered







O_2 measurements with micro-electrode



Core incubations
- measuring benthic fluxes of essential elements

Analysis*

PO_4, NO_x, NH_4, DIC, Alkalinity | QuAAtro auto-analyzer

H_2S | Spectrophotometry

SO_4 | Ion chromatography

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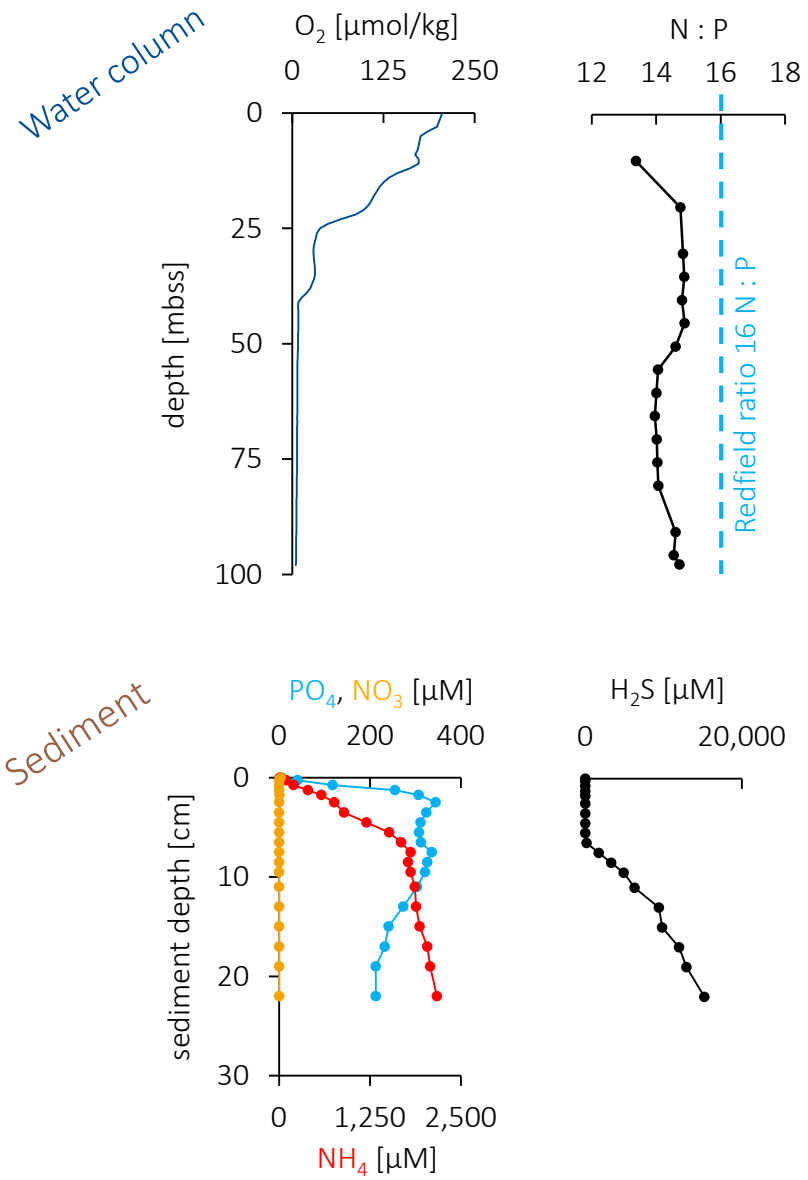
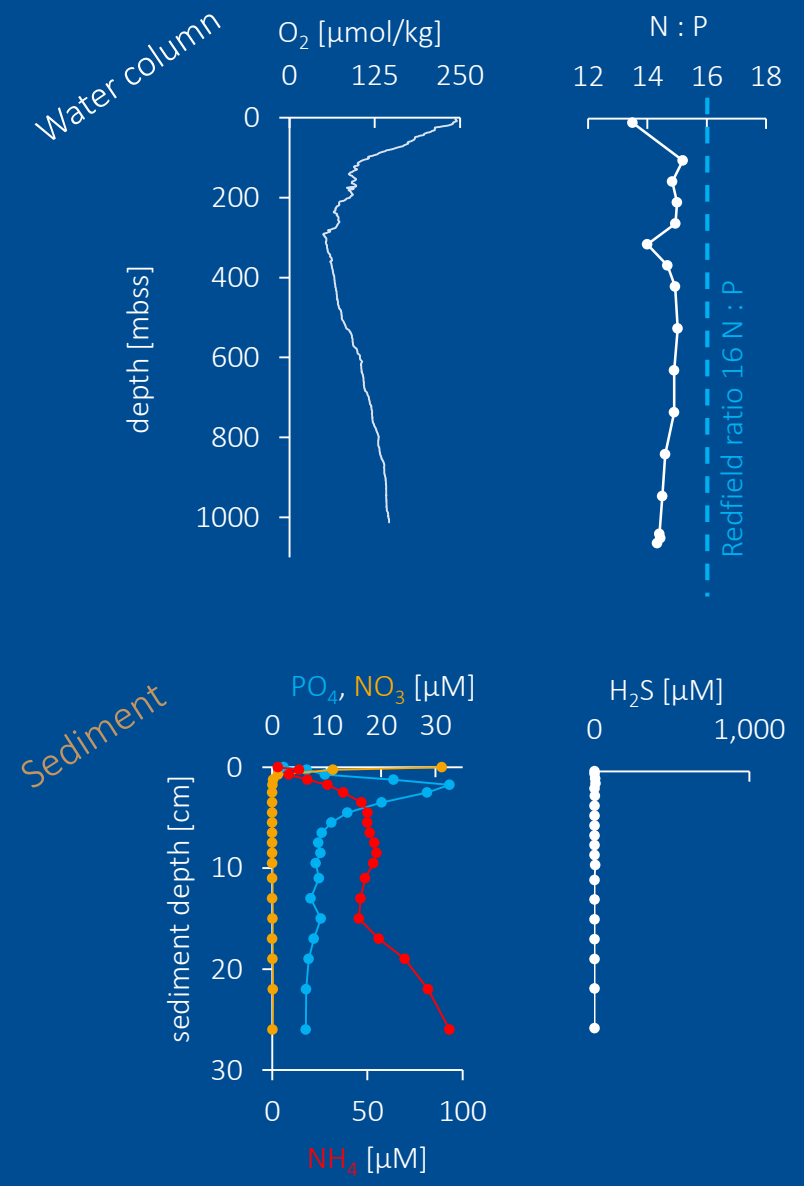


Shelf

St. 4 [105 mbss]



Slope

St. 7 [1037 mbss]

Results | Key questions

How is phosphorus (P) retained in different environments?

- High P concentration in shelf sediments
- Phosphorite fragments at depth

How do microbes mediate the sedimentary iron (Fe), phosphorus (P) and sulfur (S) cycles?

- Sulfide-oxidizing bacteria (*Thiomargarita spp., Beggiota spp.*) in the shelf's surface sediments are known to reduce the release of hydrogen sulfide to the water column (Brüchert et al., 2003)
- *Thiomargarita spp. are* capable of accumulating phosphate (Schulz and Schulz, 2005)

How do the retention mechanisms respond to varying redox-conditions?

What role do trace metals (e.g.) play in sequestering nutrients?

Next steps

(Trace) element concentrations in dissolved and particulate phases, ICP-MS

Chemical and spectroscopic characterization of sedimentary & particulate iron (Fe), phosphorus (P) and sulfur (S) pools

Isolation and characterization of sulfide-oxidizing bacteria

Student projects | Internships

There's something fishy about phosphorus cycling in the oceans

Reconstructing carbon and nutrient cycling in the Benguela upwelling system

!! earliest possible start: January 2021 !!

References

Schulz, H.D., Schulz, H.N., 2005. Large sulfur bacteria and the formation of phosphorite. Science 307, 416–418.

Brüchert et al., 2003. Regulation of bacterial sulfate reduction and hydrogen sulfide fluxes in the central Namibian coastal upwelling zone. GCA 67, 4505-4518.

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