Phosphogenesis in recent upwelling areas: the importance of microbial communities indicated by lipid biomarkers

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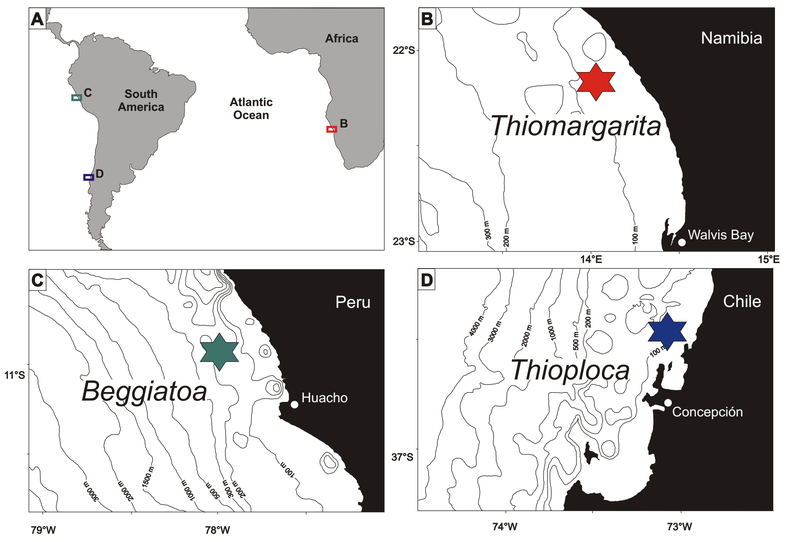
Introduction



Microbes influence the pore water chemistry of sediments and increase phosphate concentrations by degradation of organic matter. This suggests a potential for the involvement of bacteria in phosphogenesis (e.g., Krajewski et al. 1994).

Burial of phosphorus and the formation of phosphorites (phosphogenesis) in marine sediments

known

represent: an important sink in the global phosphorus cycle

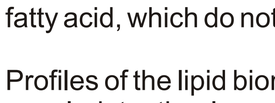
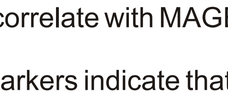
initial step: supersaturation of pore water with respect to francolite and its imminent precipitation

occur: in recently deposited sediments of upwelling regions, e.g. off Namibia, Peru, and Chile (Föllmi 1996; Schenau et al. 2000)

containing: dense populations of large nitrate-storing sulfide-oxidizing bacteria, *Thiomargarita*, *Beggiatoa*, and *Thioploca*, respectively

The aim of this work is to study the impact of microorganisms on phosphogenesis by means of lipid biomarker analysis.

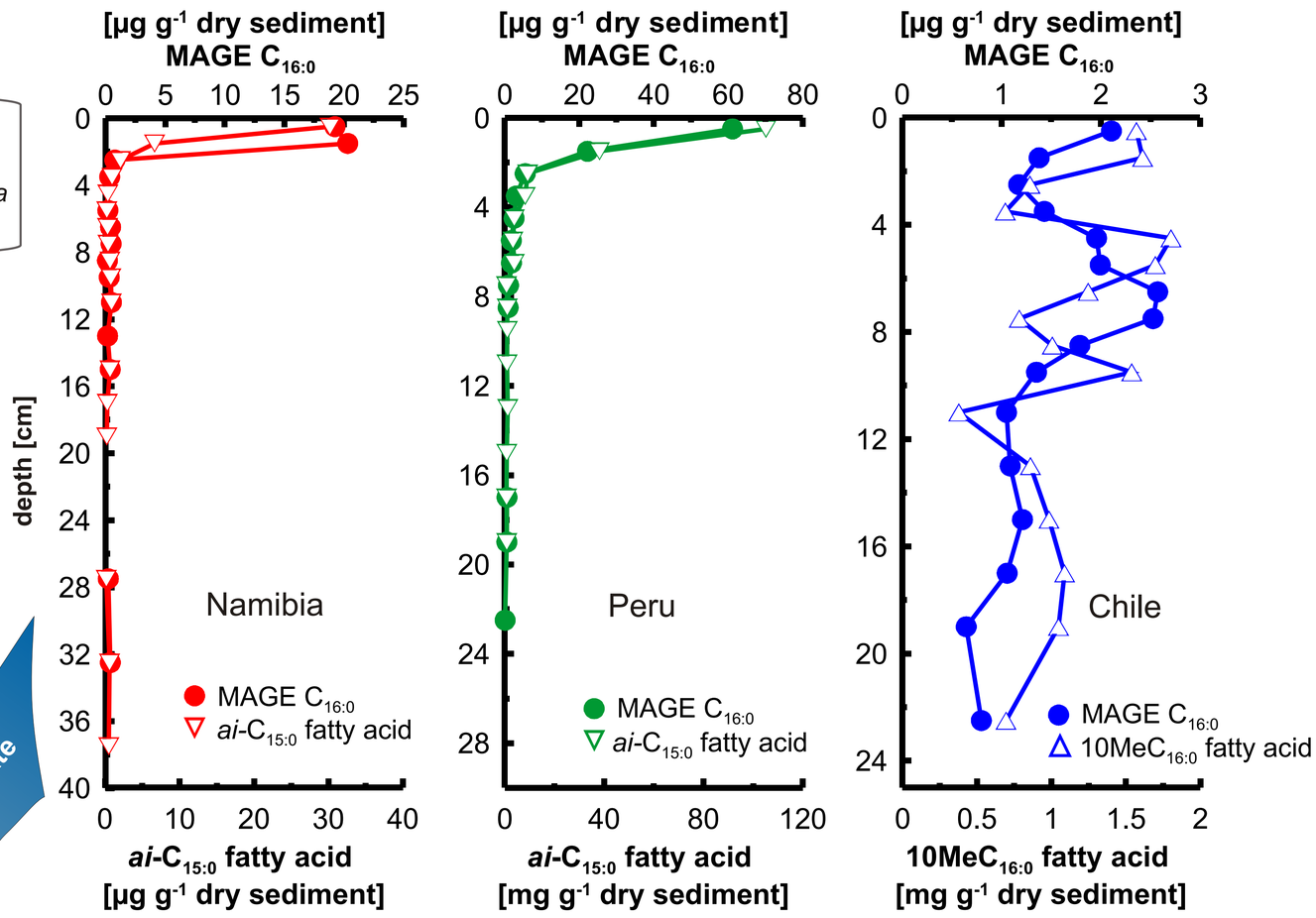
Lipid Biomarker Inventory

MAGEs	short chain branched fatty acids	*ai*-$C_{15:0}$ fatty acid:	10Me$C_{16:0}$ fatty acid:
			
sulfate reducers	mainly sulfate reducers	*Desulfosarcina*	*Desulfobacter/Desulfobacula Geobacter*

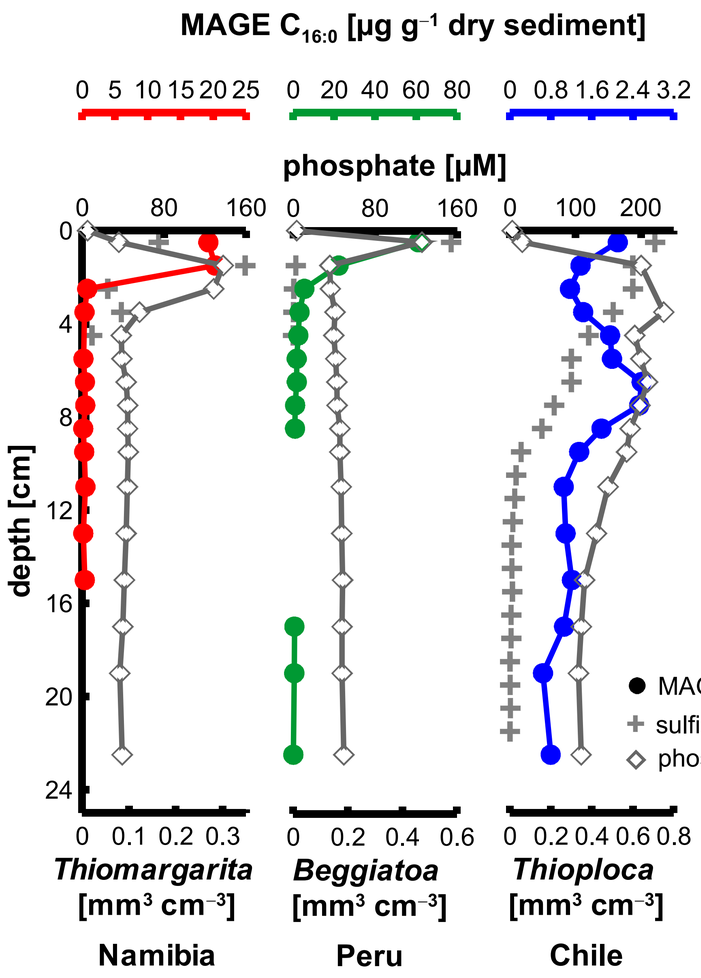
Our depth profiles of biomarkers specific for sulfate reducers reveal a close relationship between these bacteria and the occurrence of large sulfide-oxidizing bacteria. This close association reflects effective sulfur cycling.

Based on our data and previous observations, it is obvious that MAGEs derive from other sulfate reducers than branched 10Me$C_{16:0}$ fatty acid. The same seems to apply to *ai*-$C_{15:0}$ fatty acid, which do not correlate with MAGEs.

Profiles of the lipid biomarkers indicate that MAGE-synthesizing bacteria are even closer coupled to the large sulfide-oxidizing bacteria than other sulfate reducers. At the Namibian and Peruvian stations the abundance of MAGEs correlates well with the distribution of sulfide oxidizers. Profiles of Chilean sediments are more complex compared to those of Namibian and Peruvian sediments, probably because of the high vertical motility of *Thioploca*.



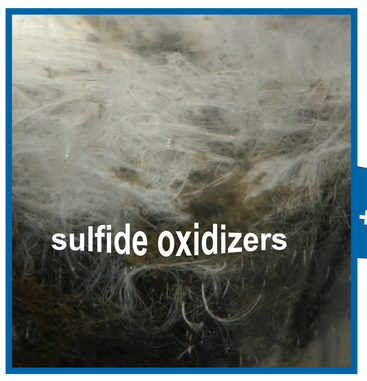
Conclusions



Connection to phosphate

motility of different large sulfide-oxidizing bacteria is crucial for the interpretation of our data

- ***Thiomargarita***: immotile, contact with nitrate or oxygen is only possible when the loose sediments become suspended (Schulz and Jørgensen 2001)
- ***Beggiatoa***: grows in mats at the oxygen/sulfide transition zone (Schulz and Jørgensen 2001)
- ***Thioploca***: filaments penetrate many centimeters deep into the sediments and are able to glide up and down to commute between the sediment surface, where they take up nitrate, and several centimeters depth to oxidize sulfide (Jørgensen and Gallardo 1999; Schulz and Jørgensen 2001).



+ sulfate reducers

1. A good correlation exists between MAGEs and the occurrence of sulfide oxidizing bacteria. — arguing for → Co-inhabitance of large sulfide-oxidizing bacteria and MAGE-synthesizing sulfate reducers.
2. Phosphate tends to accumulate where sulfate-reducing bacteria are most abundant in sediments of upwelling areas. — and → The distribution of sulfate-reducing bacteria mirrors that of the large sulfide-oxidizing bacteria off Namibia and Peru.

Based on these lines of evidence, coexisting sulfide-oxidizing bacteria and sulfate reducers may play an important role in the enrichment of phosphate in pore waters. Consequently this interaction has the potential to drive phosphorite formation.

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