

The Interchange between Life and its Geochemical Environment

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Some key questions

- *How does the chemical environment affect life?*
- *How do biological activities affect the chemical environment?*



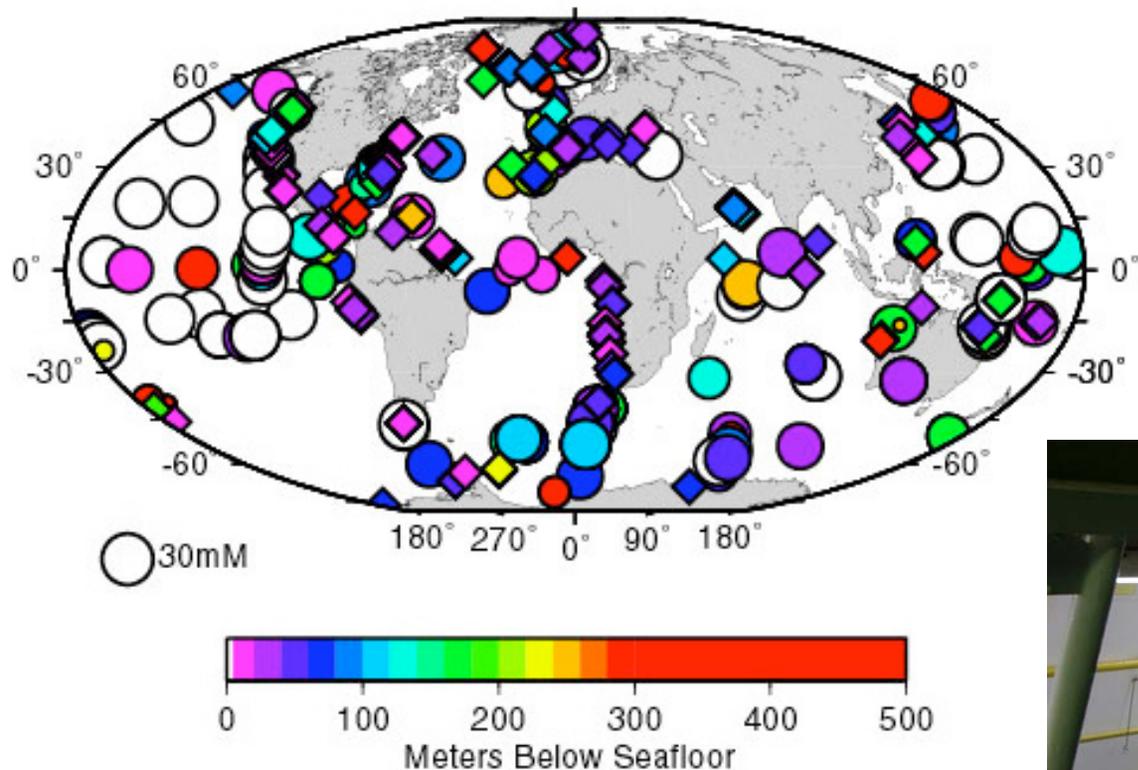
Key concepts:

- Concentrations and fluxes of biologically important chemicals (reactants and products) control locations and rates of biological activities.
- Biological activities in turn control chemical concentrations and fluxes.
 - Some such control is a direct result of biological activities
 - Example: production of CO_2 by oxidation of organic matter
 - Other such control is an indirect result of biological activities (it results from chemical responses to biological activities)
 - Example: dissolution of CaCO_3 as CO_2 concentrations rise.

Interchange between life and chemicals: Example 1

- Production of O₂ by photosynthesis and subsequent burial of organic carbon keeps Earth's atmosphere rich in oxygen
 - This abundance of O₂ makes our life possible.
 - It also enhances microbial activity throughout the anaerobic world (by priming the “bucket brigade” of electron donors and electron acceptors - e.g., with oxygen used to oxidize nitrogen and manganese, which are in turn reduced to oxidize iron, which can in turn be reduced to oxidize sulfur, which can in turn be reduced to oxidize carbon and hydrogen).
- Production of organic matter by photosynthesis provides most of the fuel for heterotrophic life on Earth.

Interchange between life and chemicals: Example 2



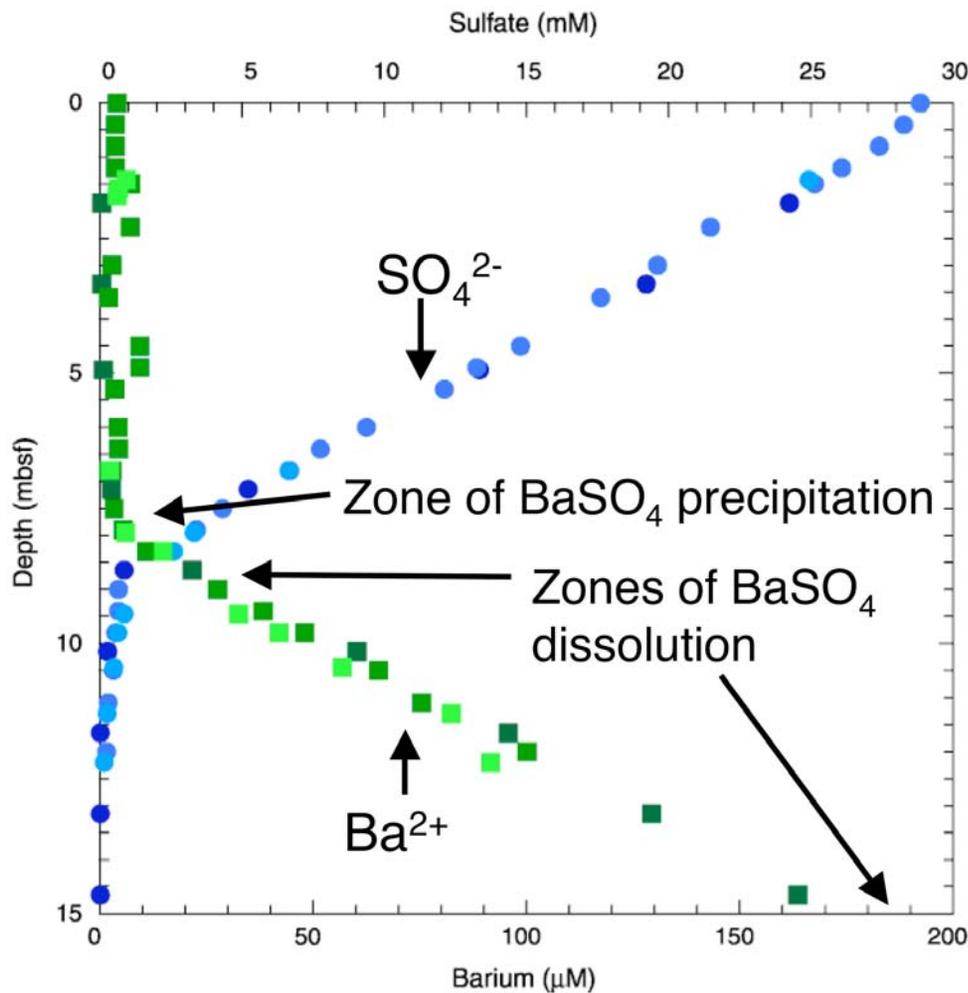
D'Hondt et al., 2002, *Science*.

Dissolved oceanic SO_4^{2-} fuels seafloor SO_4^{2-} reduction...

which, with subsequent FeS_2 precipitation is the principal sink of sulfur from the world ocean.



Biological activities & mineral weathering / precipitation mediate each other: Example 1



After bacterial activity draws down dissolved SO_4^{2-} concentrations in ocean margin sediments, solid BaSO_4 dissolves...

which fuels further SO_4^{2-} reduction and releases Ba^{2+} to diffuse upward...

where it precipitates again with SO_4^{2-} ...

which will be dissolved to fuel SO_4^{2-} reduction at some future time (as the seafloor migrates upward)

ODP Leg 201 Shipboard Scientific Party (2003).

Biological activities & mineral weathering / precipitation mediate each other: Example 2(?)

Altered glass from oceanic pillow basalts

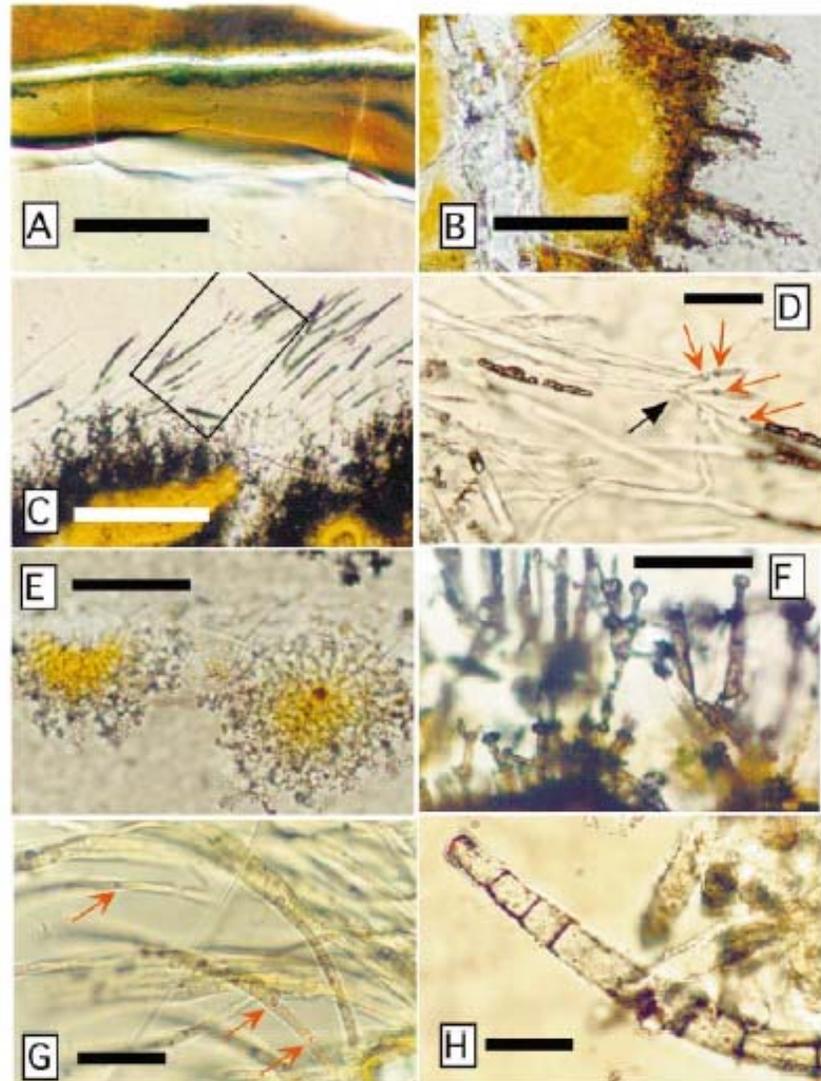
Influence of biological activity on mineral alteration is so pervasive that some forms of alteration have been interpreted as evidence of life:

A) 186 mbsf (48 mbbs), 0.4 Ma

...

H) 985 mbsf (37 mbbs), 145 Ma

Fisk et al. 1998, *Science*.



The End.