Chemical Gradients and Life

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Key concepts:

- Concentrations and fluxes of biologically important chemicals (reactants and products) control locations and rates of microbial activities.
  - Chemical fluxes are controlled by concentration gradients and transport processes (diffusion, turbulence and/or advection).
- Microbial activities in turn control chemical concentrations and fluxes (by controlling concentration gradients).

Key concepts:

All energy-producing metabolic activities are “redox” reactions.

In other words, each energy-producing reaction requires an oxidant (electron acceptor) and a reductant (electron donor).

Example: $O_2 + CH_2O \rightarrow CO_2 + H_2O$

Electron acceptor

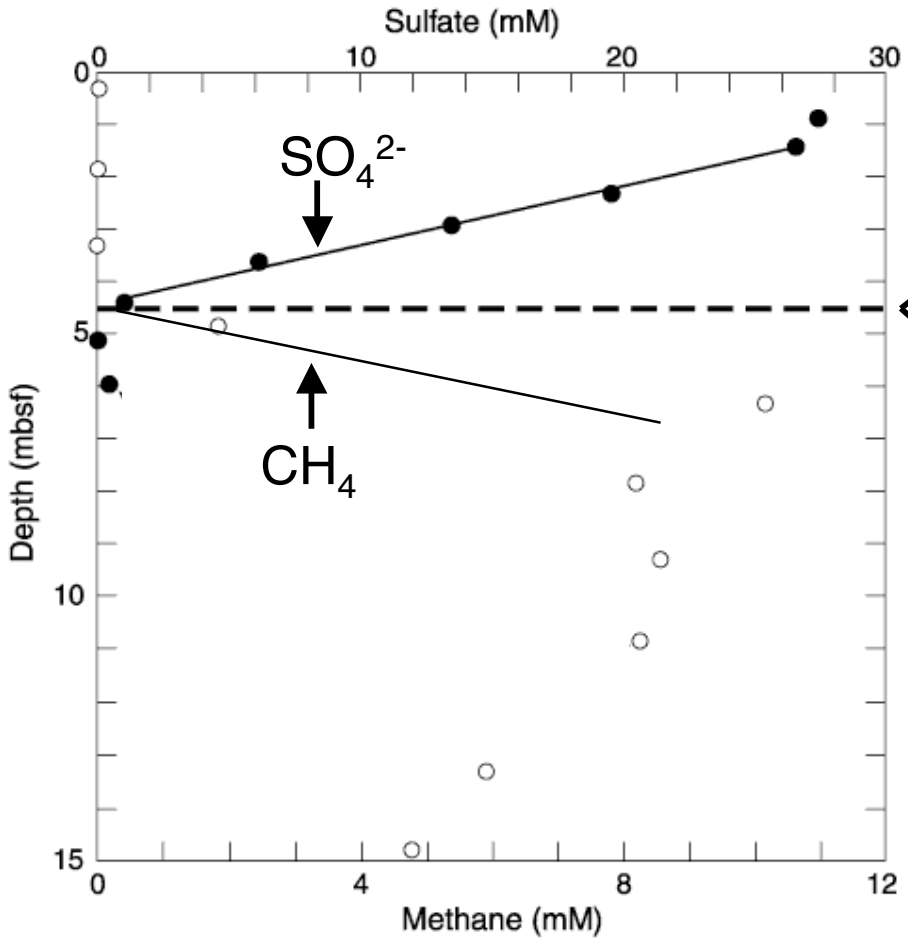
Electron donor

Oxidized product

Reduced product

Reduced and oxidized products may serve as electron donors and electron acceptors for other reactions.

Example of chemical gradients and life
(Anaerobic methane oxidation zone)



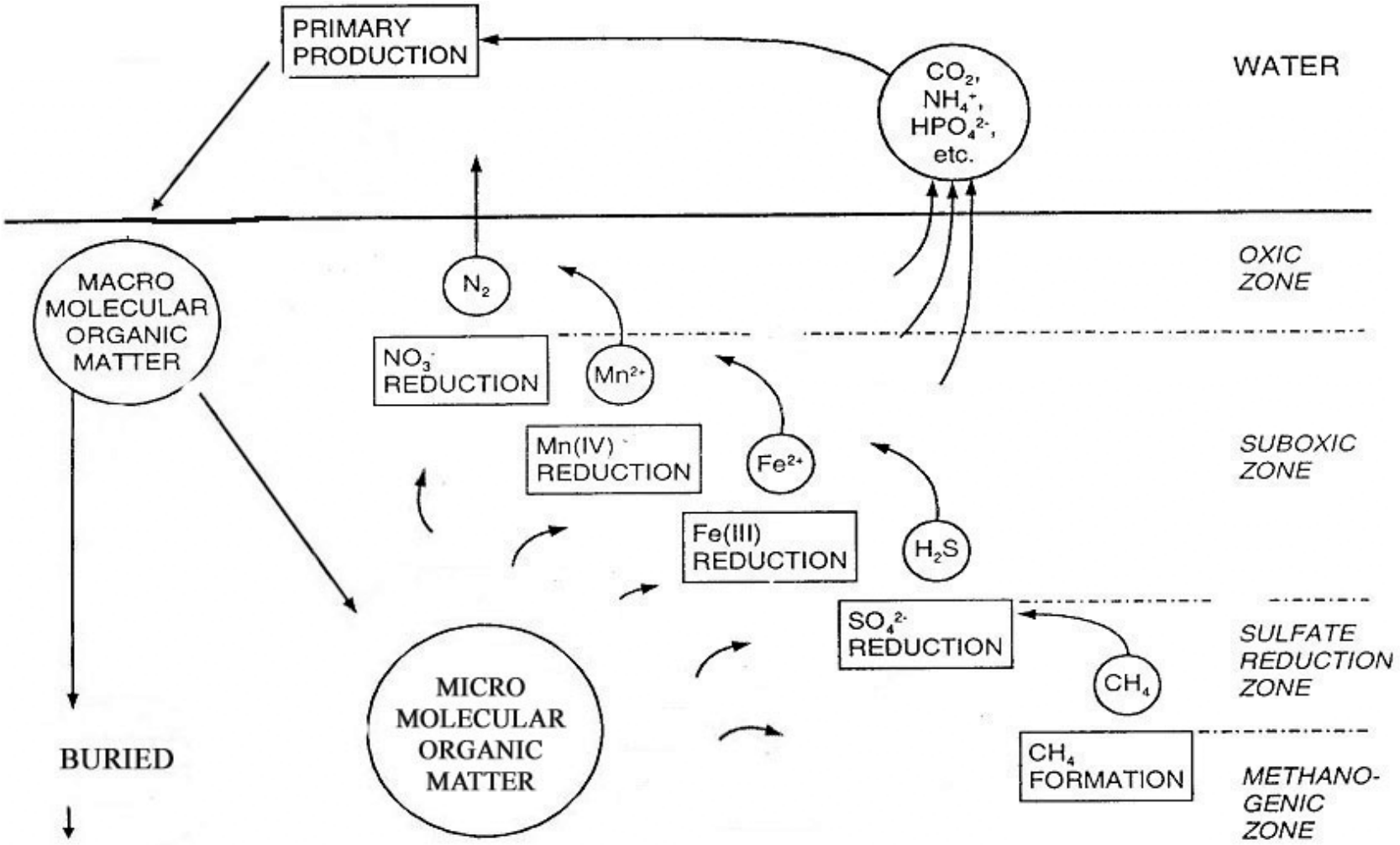
Sulfate-reducing
Methane oxidation zone

Arrows mark directions of chemical fluxes.

The SO_4^{2-}/CH_4 front typically contains a distinct anaerobic methane-oxidizing community.

Figure from Shipboard Scientific Party, 2003 (ODP Leg 204 Initial Report).

A typical succession of biogeochemical redox zones (subsurface example)



Fenchel and Jorgensen (1977).