## Unit 2.4 Microbes-mineral interactions, microbial mats

**Source:**

- Notes: Microbes-mineral interactions
- Notes: Microbial mats

**Introduction:**

- Microbes→diverse environment
- Geomicrobiology: interdisciplinary approach to understand geology and microbiology.
- Discuss microbes present in various environments.
- Macroscopic to microscopic
- In this we understand the microbe and mineral interaction

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| Mineral and rocks<br>↓<br>Nutrients and living habitats |
| Microbes<br>↓ Impact<br>Rock and mineral weathering and diagenesis rates through their effects on mineral solubility and speciation |

- Among all minerals, **silicates and oxides** are most common and best studies in terms of mineral-microbe interaction.
- **For ex.:** in presence of oxygen, aerobic microorg interact with oxide and silicates to obtain essential nutrients and use them as protection from lethal habitats. Similarly, in absence of oxygen (anaerobic) microorg thrive by respiring oxidized forms of metals.

**Discussion:**

- **Phosphorus and Fe** both can act limiting agent (what is limiting agent)
- Therefore, microbes colonize in those rocks that contains P and Fe.
- Micro-org (MO) can recognise Fe containing rocks and accelerate the release of Fe from silicate such as Hbl and Felds.
- Once MO attached to a mineral surface because of sufficient nutrient supply, they send signal to other MO and gradually build a community called **BIOFILM**. For example, Lichens or other MO associated with lichens. There function is to access atm N2, and inorganic nutrients trapped in minerals and rocks.

- **Microbial mats:** specialised group of biofilms.
    - Many microbial groups laterally tightly compressed into a thin mat of biological activity. Microbial mats (MM) range from **several mm to cm thick** and are vertically stratified.
    - MM are mostly associated with env such as **benthic–planktonic interface** of hot springs, deep-sea vents, hypersaline lakes and marine estuaries.
    - Microbial mats are **unique communities** because the interdependent microbial components form clearly stratified and often distinctively colored zones.
    - Mats are often found in extreme environments or in environments where conditions fluctuate rapidly.
    - Eg of MM: Stromatolites (first indicator of life on earth)
    - Once biofilm community developed, minerals and rocks undergo weathering (i.e., dissolution, precipitation, and transformation). The order of weathering is opp of Bowen stability series.

> Olivine → pyroxene → amphibole → Biotite → orthoclase → muscovite → quartz-
> Ca-rich Plg → Ca/Na plagioclase → Na-rich plg →
> Orthoclase → muscovite → quartz.

- **Biomineralization**

  Microbial activity also contributes to the formation of different minerals. For ex. Oxides, Sulphides, and carbonates.
    - Microbe-mineral interaction also has a significant contribution to improve soil fertility. For ex. Due to microbial activity, **K released from silicate minerals**, which is considered as an important ingredient for plant growth.
- **Toxic elements**
    - It is well known that microorganisms can dissolve different minerals and use them as sources of nutrients and energy. The majority of rock minerals are rich in vital elements (e.g., P, Fe, S, Mg and Mo), but some may also contain toxic metals or metalloids, like arsenic.
    - For ex. Arsenic release bacterial community *Burkholderia fungorum* dissolves apatite.
- **Microbial dissolution of minerals**
    - **Siderophores**: are low mol wt organic ligands that form strong complex with metals and radionuclides in aerobic env.
    - These siderophores released due to microbial activity.
    - *Pseudomonas mendocina* can produce siderophores to extract Fe from goethite, hematite, kaolinite etc.
    - Microbial activity (oxidation) of metal sulfphides in coal mines and metal sulfide deposits.
    - Bacteria oxidise metal sulphides → significant env problems (acid mine drainage); and economic adv (e.g., recovery of Au).
- **Acid mine drainage**
    - As acid mine drainage flows across the land its high acidity and metal content can kill vegetation and other biota.

- Presence of certain biota: *Acidithiobacillus ferrooxidans* indicates acid mine drainage water.

- **Recovery of precious metals**
  - Low concentration of precious metals.
  - Microbial leaching and recovery are common method to recover precious metals e.g., Au, and Cu.
- **Biologically controlled mineralisation (BCM)**
  - refers to the process by which microorg exert a genetic and biochemical control over the nucleation and growth of certain minerals.
  - Best ex is Magnetite and Gregite
  - Magnetosomes: formation of magnetite and Gregite by microbial activity.
- **Biologically induced mineralisation (BIM)**
  - Mineral precipitation induced by microbial activity via alteration of local pH, removal of certain inhibitors, and mineral saturation state. For example, biogenic precipitation of carbonates (e.g., aragonite, siderite, dolomite, etc.) in gulf of Mexica, Bahams, caves, and saline lakes/lagoons.
  - In caves deposits, the MO increases pH providing nucleation sites for carbonate deposits.