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Microorganisms and Minerals Interactions

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A mineral is a naturally occurring homogeneous inorganic substance generally in crystalline form with a definite chemical composition. They are usually in solid form except fossil fuels, natural water and mercury (Haldar 2018). Microorganisms interact with minerals which are present in soil. The microorganisms and minerals have coevolved over the years (Li et al 2013). Mineral microbe interactions are important for the supply of nutrients to plant growth and development, biogeochemical cycling of elements, improving quality of environment and formation of ore deposits (Dong et al. 2022).

Role of Microorganisms During Microbe-Mineral Interaction

Mineral weathering

Acidolysis

Various acids such as carbonic acid, gluconic acid, nitric and nitrous acid etc are released by the microorganisms through their metabolic activities to cause dissolution of minerals (Uroz et al. 2009, Dong et al. 2022).

Chelation

Chelating molecules like siderophores and catechol derivatives chelate iron ions and help in dissolution of iron containing minerals such as olivine, hornblende etc. (Uroz et al. 2009; Page et al. 1984; Liermann et al. 2000).

Mineral precipitation

Formation of mineral deposits are significantly influenced by the microorganisms (Hoffmann et al. 2021; Crosby and Bailey 2012). Bacteria help in mineral precipitation by changing local ion concentration, pH or acting as nucleation places for crystallization (Hoffman et al. 2021). Several bacteria, fungi and algae induce carbonate precipitation by

different metabolic activities like ammonification (Lange-Enyedi et al. 2024), sulfate reduction (Zhang 2020), and ureolysis (Hammes et al., 2003).

Mineral Transformation

Microorganisms play important role in formation, dissolution and deterioration of various kinds of minerals (Gadd, 2013). The bacteria such as *Acidithiobacillus ferroxidans*, and *Acidithiobacillus thioxidans* are involved in biooxidation of arsenic (Hackl and Jones 1997). Iron transformation is mediated by *Thiobacillus ferrooxidans*, *Ferrobacillus ferrooxidans*, *Gallionella*, *Leptothrix ochracea*. The sulphur transformation is carried out by *Beggiatoa*, *Thiobacillus*, and *Rhodobacteriineae*. The *Proteus vulgaris* and *Escherichia coli* facilitate transformation of copper compounds (Mulder and Van veen 1968)

Minerals Roles In Helping Microbial Communities

Protection

Minerals help in survival of microbial communities by protecting them from temperatures extremes, uv radiations and physical abrasions through pores, cracks and crevices within minerals (Fomina and Skorochod 2020, Dong et al. 2022).

Nutrients

Minerals provide several nutrients such as phosphorus, potassium, calcium, magnesium, sulfur, iron, sodium etc. for the growth and development of microorganisms (Shock 2009; Li et al 2019; Dong et al. 2022).

Energy

Through oxidation-reduction reactions minerals also act as source of energy to microorganisms (Ehrlich 1996; Shock 2009; Dong et al. 2022).

Uses Of Microbe Mineral Interactions

Mineral solubilizing microorganisms improve plant growth and development by making available nutrients such as P, K and Zn (Devi et al. 2022). Through the process of bioleaching microbe mineral interactions help in extraction of metals like gold and copper from low grade ores and minerals (Bosecker 1997). Application of microbe–mineral suspensions to contaminated areas leads to stabilization of toxic metals either through precipitation or incorporation of metals into biominerals (Dong et al. 2022).

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