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Effect of Semiconducting Iron Mineral Goethite Photoreduction on Microbial Community in the Natural Photocatalytic System of Hydrosphere Euphotic Zone

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Natural photocatalytic system of hydrosphere euphotic zone is the critical zone for the interaction of sunlight-minerals-microorganisms and element cycling, where semiconducting minerals exist widely and iron-bearing goethite is the representative one. It has investigated the effect of Fe^{2+} dissolved by goethite photoreduction on microbial community structure, diversity and element cycling. Photoelectrochemical measurements tested photoelectric response and redox activity of goethite, which demonstrated the significant photoelectric property with 44% increment of the average photocurrent density relative to the dark current density. Dissolved Fe^{2+} of goethite photoreduction in the group with light was about 1640.00% higher than the group without light after an experimental cycle (12-day reaction). It indicated goethite can generate photoelectrons to reduce Fe(III) to Fe(II) in the mineral structure and release it into the environment in the form of dissolved Fe^{2+} with light irradiation. Goethite photoreduction transform photoelectrons into valence electrons and convert solar energy into chemical or biomass energy. Dissolved Fe^{2+} further affect the structure and regulate the decrease of microbial community diversity. The emergence of dominant *Vibrio* and *Pseudoalteromonas* associated with iron oxidation and transport protein suggested their obvious selectivity and adaptability with Fe^{2+}. Dissolved Fe^{2+} from photoreduction of semiconducting iron minerals may be one of the important sources of ferrous ions in hydrosphere euphotic zone, providing energy to microorganisms for growth and regulating the metabolic functions of autotrophic bacteria and the electron transfer of heterotrophic bacteria, as well as the changes of energy metabolism in hydrosphere euphotic zone. This work revealed the photoreduction process of semiconducting goethite was remarkable, giving rise to a non-negligible dissolved Fe(II) and its selective effect on the microbial community and realizing the photoelectrons from semiconducting minerals can be indirectly used by microbes. This light-induced interaction between semiconducting minerals and microorganisms may also further regulate correlative metabolic pathways of biogeochemical carbon cycle in the euphotic zone, and the improvement of the oxidation capacity of organic substrates will influence biogeochemical carbon balance and then drive carbon cycle in the natural photocatalytic system of hydrosphere euphotic zone.