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Metabolic flexibility of the Fe(II)-oxidizing phototropic strain Rhodopseudomonas palustris TIE1 and its potential role in microbial iron cycling

C. Schmidt, K. Oswald, E.D. Melton, and A. Kappler
University Tuebingen, Geomicrobiology Group, Tuebingen, Germany (caroline.schmidt@uni-tuebingen.de)

The biogeochemical conversion of iron(II) and iron(III) is widespread in many aquatic and terrestrial environments. In the anoxic regime of soils and sediments the conversion and alternation of the iron redox state is predominantly run by microorganisms that are thought to gain life-sustaining energy by the oxidation and/or reduction of ferrous/ferric components. The spatial arrangement of microbial iron(II) oxidation and iron(III) reduction is largely controlled by the availability of the required electron acceptor and electron donor, as well as the essential source of energy (i.e. light or chemical energy). The physico-chemical patterns of many microbial environments undergo dynamic variations (i.e. diurnal and seasonal changes) as a function of natural external forces (i.e. seasonality, storm events, algae blooms) which strongly affects the local budget of organic carbon and nutrients, as well as the day light penetration. Such fluctuations force microorganisms either to follow the flow of substrate or to switch their metabolism to alternative electron acceptors and/or donors.
Different photoferrotrophic bacteria have been shown to be able to grow either on organic (heterotrophic) or inorganic (autotrophic) substrates while exploiting light as their energy source. Within the frame of this study the preference for organic substrates (lactate and acetate) and/or ferrous iron (in simultaneous presence) for photo(ferro)trophic growth of Rhodopseudomonas palustris TIE1 has been investigated in detail. Rates of iron oxidation, acetate/lactate consumption and growth have been followed over time as a function of different lactate to acetate to iron(II) ratios. Additional experiments have been designed to evaluate the potential of Rhodopseudomonas palustris TIE1 to contribute to the redox cycling of iron. TIE1 has been grown in a batch set-up in which the iron(III)-reducing strain Shewanella oneidensis MR1 has been incubated at different ferrihydrite concentrations in the presence of lactate producing dissolved and solid-phase Fe(II). The depletion of dissolved iron(II) that was metabolically produced by Shewanella oneidensis MR1 and the formation of Fe(II)/Fe(III) mineral phases during Fe(II) reoxidation by strain TIE1 was monitored as a function of time in order to follow the microbially mediated iron redox cycling. The obtained results provide new insights in physiological properties, energy acquisition, metabolic flexibility, survival strategies and interspecies communication of photoferrotrophic microorganisms.