Contribution of Fe(II)-oxidizing bacteria to carbon fixation and arsenic immobilization in paddy soil

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The fixation of inorganic carbon has been documented in most microaerophilic Fe(II)-oxidizing bacteria isolated from fresh water and marine, but this process has not been well characterized within paddy soil in microaerophilic zones. To illustrate the microaerophilic transformation of soil elements and the implications for redox-sensitive soil contaminants, we used gel-stabilized gradient systems to investigate carbon fixation and arsenic immobilization during microbial Fe(II) oxidative mineralization under microaerophilic conditions. DNA-SIP was employed to interpret the ^{13}C content of biomass and identify the chemolithoautotrophic bacteria coupled with Fe(II) oxidation. The results show that Fe(II)-oxidizing bacteria in microaerophilic zones can assimilate inorganic carbon. Maximum rates of chemoautotrophy were detected in the absence of arsenic and chemosynthetic biomass production was 8.02 mmol C m^{-2} day^{-1}, which is in the range of growth yields reported for iron oxidizing bacteria. Bacteria, such as *Bradyrhizobium*, *Cupriavidus*, *Hyphomicrobium*, *Kaistobacter*, *Mesorhizobium*, *Rhizobium*, unclassified *Phycisphaerales*, and unclassified *Opitutaceas*, demonstrated their potential in assimilating inorganic carbon during iron oxidation. However, As(III) affected the diversity of functional bacteria for carbon assimilation. Total Fe concentrations increased and were accompanied by Fe(III) oxyhydroxide precipitation and decreased in dissolved As(III) concentrations. In the minerals produced with coexisted As(III), most arsenic ultimately existed as As(V), indicating the occurrence of As(III) oxidation accompanied with arsenic immobilization. The potential for microbially mediated As(III) oxidation is revealed by the arsenite oxidase gene, denoting attributes of biological processes for As(III) oxidation. Overall, the results of this study demonstrate that inorganic carbon fixation during the iron oxidation can occur to increase the carbon capture in micro-oxic soils, which also imposes important impacts on the mobility of metal pollutants, such as arsenic.