Carbon and hydrogen isotope signatures associated with microbial iron reduction

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Iron-reducing bacteria can use both organic carbon and hydrogen as energy sources for iron reduction. The goal of this study is to determine the isotopic constraints on microbial iron reduction under organic carbon or hydrogen conditions. Two mesophilic iron-reducing bacteria (Shewanella strains CN32 and BrY) were studied, which used lactate or H2/CO2 as the energy and carbon sources. Ferric citrate or amorphous iron was used as the electron acceptor. Carbon isotopes of biomass were similar (about -25 per mil) under both H2/CO2 and lactate conditions. However, the fractionation between biomass carbon and final CO2 was averaged 15 per mil smaller under the H2/CO2 conditions than under the lactate conditions (1000 ln (alpha) = -13.9 vs. 1.0 per mil). Carbon isotope fractionations between siderite and co-existing CO2 were also smaller under H2/CO2 conditions than under lactate conditions (1000 ln (alpha) = 8.4 vs. 13.7 per mil). Hydrogen isotopes of the biomass averaged -154 per mil under the H2/CO2 conditions and averaged -148 per mil under the lactate conditions in the same medium water (D/H = -46.8 per mil). These biomass D/H ratios were similar despite that the initial H2 and lactate had a 50 per mil difference (-157 vs. -207 per mil). When cells were grown in a deuterium-enriched medium water (D/H = 155 per mil), the D/H ratio of biomass increased to -88.5 per mil under H2/CO2 conditions and increased to -132 per mil under lactate conditions. Thus, the medium water had a greater effect on biomass D/H ratios under H2/CO2 conditions than under lactate conditions. Substrate H2 or lactate also contributed to the D/H ratios of the biomass. These results indicate that carbon and hydrogen isotopes may be used to delineate the biochemical pathways during iron reduction involving these types of mesophilic strains.

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