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Methane production by anoxygenic phototrophic Fe(II)-oxidizing bacteria

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Methane (CH_4) is a very potent greenhouse gas and is biotically mainly produced by methanogens. In recent years CH_4 production was also observed for a variety of bacteria, archaea, fungi and plants. So far it is not known if anoxygenic phototrophs can also produce CH_4. Some of these phototrophs can use Fe(II) as an electron donor and are called photoferrotrophs. In this study we investigated if photoferrotrophs can produce CH_4 while growing photoheterotrophically with acetate or photoautotrophically using Fe(II) or H_2. In cultures that were treated with ^{13}C-labeled hydrogen carbonate, stable carbon isotope values of CH_4 increased with incubation time, unambiguously demonstrating the conversion of ^{13}C– hydrogen carbonate to $^{13}CH_4$ by various strains of photoferrotrophic bacteria. The highest CH_4 concentrations were produced by the purple non-sulfur bacterium *Rhodopseudomonas palustris* TIE-1. This strain produced CH_4 when grown with acetate, Fe(II) and with H_2. We also observed biotic CH_4 production by the green-sulfur Fe(II)-oxidizing bacteria *Chlorobium ferrooxidans* KoFox and *Chlorobium* KB01 when grown with Fe(II) as electron donor. In summary our results confirmed that photoferrotrophs can produce CH_4 as a by-product while oxidizing their substrates during growth under phototrophic conditions. Based on the estimated abundance of photoferrotrophs on early Earth, our data suggest that photoferrotrophs could be considered as an additional CH_4 source.