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

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Methane (CH₄) is a very potent greenhouse gas and is biotically mainly produced by methanogens. In recent years CH₄ 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 CH₄. 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 CH₄ while growing photoheterotrophically with acetate or photoautotrophically using Fe(II) or H₂. In cultures that were treated with ¹³C-labeled hydrogen carbonate, stable carbon isotope values of CH₄ increased with incubation time, unambiguously demonstrating the conversion of ¹³C– hydrogen carbonate to ¹³CH₄ by various strains of photoferrotrophic bacteria. The highest CH₄ concentrations were produced by the purple non-sulfur bacterium Rhodopseudomonas palustris TIE-1. This strain produced CH₄ when grown with acetate, Fe(II) and with H₂. We also observed biotic CH₄ 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 CH₄ 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 CH₄ source.