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The isotopic signature of biologically produced Hydrogen and its impact to the atmosphere

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The shortage, increase in cost and climate impact of fossil fuels leads to an increased interest in renewable and clean energy sources. Molecular hydrogen (H2) is considered as one of the most important future energy carriers, however, its global atmospheric budget is not well constrained. With respect to an increasing relevance of H2, a fundamental understanding of the sources and sinks of the global H2 cycle is indispensable. One source, which becomes more and more important, is biohydrogen, biologically produced H2.
The isotopic signature of biologically produced H2 is assumed to be highly depleted due to thermodynamic reasons, but almost no measurements exist up to now. We investigated the isotopic composition of H2 produced during biogas formation and from pure microorganism cultures. The results confirm the massive deuterium depletion of biologically produced H2 as predicted by Bottinga (1969), who calculated thermodynamic fractionation factors for hydrogen exchange in the system hydrogen – water vapor. As expected for a thermodynamic equilibrium, the fractionation is independent of used substrates, production conditions and even bacterial species. Biological hydrogen thus has a very high leverage in the hydrogen isotope budget and although its atmospheric source strength is smaller than photochemical or combustion sources, it has to be included in global isotope budget calculations.