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Low temperature formation of molecular hydrogen and hydrocarbons in lab experiments with mafic rocks and minerals: From experimental artifacts to assessing the rates and reactions of processes.

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Despite the huge body of research on the formation of molecular hydrogen by natural processes as e.g. serpentinization at temperatures above 200°C [1], the findings of processes responsible for natural hydrogen occurences and experimental investigations on geochemical hydrogen formation on mineral surfaces at temperatures lower than 100°C are highly controversial. Whilst some authors detected increasing H2 concentrations in the gas phase of experiments at 30 to 70°C over time scales of weeks to month [2], other groups identified possible experimental artifacts possibly influencing the observed hydrogen formation. In addition, the formation of methane – and some higher hydrocarbons – in these low temperature experiments is an open and hotly debated finding – with regard to possible artifacts contributing and reactions involved [3]. The explanations include i.a. the release of hydrocarbons from septa in the sample containers and the release of hydrocarbons from gas-fluid inclusions in the rock/mineral material used. But the increasing number of findings of H2-enriched and hydrocarbon-rich gases in areas outside the classical hydrocarbon provinces call for a sound understanding of processes involved and knowlegde of rates of formation at temperatures well below 200°C.

Therefore we conducted experiments at near-ambient conitions (30°C) for weeks in glass vials with a size-fraction of a mafic rock in the presence of water and an initial gas phase of N2, N2+CO2, N2+CO2+H2. In addition, we compared different closures on the glas vials, and used 13C-labelled CO2 to differentiate hydrocarbon origins between the mentioned artifacts – septa and released gas-fluid inclusions or „in-experiment“ reduction of CO2 to methane. With the results of the gas, fluid and solid analyses we hope to stimulate the discussion again, initiate and contribute to interlab comparison experiments leading in the long run to „best practises“ on experiments for studying the (geo)chemical low temperature formation of H2 and hydrocarbons.

[1] McCollom et al. (2016) Geochim. Cosmochim. Acta 181: 175-200. [2] Neubeck et al. (2014) Planet. Sp. Sci. 96: 51-61. [3] McCollom & Donaldson (2016) Astrobiol. 16: 389-406.