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Low-temperature hydrogen production by water-mineral interaction with many different mineral species

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Our recent experiments show that H_2 is generated at low concentrations by addition of distilled water to various individual minerals or mineral mixtures at one atmosphere and 20°C. H_2 production began within one to seven days and continued for a week or more. Materials that generated H_2 under these conditions include siderite, epsomite, anorthosite, hematite, magnetite, olivine, gypsum, kaolinite, and the MGS-1 Mars regolith simulant. H_2 production was not observed for samples of basaltic glass, bronzite, hydrated silica, or mineral-free distilled water. Low-temperature H_2 production by water-rock interaction has previously been reported for MGS-1 [1] as well as for magnetite and olivine [2]. The simplest explanation of this general result is H_2 production by water oxidation of reduced iron or other reduced metal species. Testing of this hypothesis will require direct measurement of metal concentrations and metal redox states for all the minerals. Although the chemical formulae for some of these minerals (epsomite, anorthosite, gypsum, kaolinite) do not contain iron, reduced iron is known to be associated with them, by substitution for structural cations (e.g., epsomite), adsorption (e.g., kaolinite), or presence in associated accessory minerals (e.g., anorthosite). Although the iron in hematite is typically considered to be fully oxidized, our hypothesis for the cause of its H_2 production requires a fraction of the iron in this hematite to be reduced.

References

[1] Adcock, C.T., et al. (2020), *51st LPSC,* 1609.

[2] Mayhew, L.E., et al. (2013), *Nat. Geosci*, 6(6), 478-484.