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New thermodynamic and kinetic constraints on H_2 production during ferroan brucite reaction at low temperature

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The alteration of ferroan brucite, a common by-product of serpentinization, has been proposed as a H_2 source at low temperature. Here, synthetic ferroan brucite with Fe/(Fe+Mg) = 0.2 was reacted with pure water at temperatures ranging from 348 to 573 K in 29 experiments either conducted in gold capsules or Ti-based reactors. H_2 production monitoring with time and characterization of the reaction products revealed the occurrence of the following reaction: 3 $Fe(OH)_2^{brucite}$ = Fe_3O_4 + H_2 + 2 H_2O. This reaction proceeds completely in ~ 2 months at 378 K and is thermally activated. The small grain size of the synthetic brucite (40-100 nm) is similar to observations in natural samples, and is probably responsible for the high reaction rate measured. H_2 production reached a plateau and Fe-bearing brucite also precipitated as a reaction product, suggesting the achievement of equilibrium. The thermodynamic properties of $Fe(OH)_2$ were refined based on the experimental dataset and differ by less than 5 % from previous estimates. However, ferroan brucite is predicted to be stable at an hydrogen activity one order of magnitude lower than previously calculated. As a result, significant H_2 production during ferroan brucite alteration at low temperature requires efficient fluid renewal. Such a mechanism strongly differs from olivine serpentinization which can occur even at high activity in H_2 and thus with limited water renewal.