Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.35524

# Reactivity of ferroan brucite regulates hydrogen production in serpentinizing systems

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Serpentinization is a significant planetary process that has substantially impacted the biogeochemical evolution of Earth and Mars. It is a mineral hydration reaction involving the oxidation of ferrous iron in olivine and the resulting production of molecular hydrogen. Research on the kinetics of hydrogen production during serpentinization has predominantly focused on primary reactions, such as the conversion of olivine into Fe(III)-bearing serpentine and magnetite. However, secondary reactions involving serpentinization byproducts can also contribute to hydrogen production. For example, while brucite acts as a ferrous iron sink and inhibits hydrogen production at low to moderate temperatures during primary serpentinization, its further reaction with dissolved silica might promote hydrogen generation. Although field studies suggest this process is thermodynamically feasible, a mechanistic experimental dataset needed to quantify hydrogen fluxes from such reactions is lacking. Here, we report the results of a series of kinetic experiments in which we reacted synthetic Fe-rich brucites (XMg: 0.4- 0.8) with $SiO_2$-rich solutions under anoxic and reducing conditions at temperatures ranging from ambient to 150°C. This specific range of brucite compositions was selected to reflect the reaction end-products of the diverse olivine compositions found on Earth and Mars. Compared to terrestrial analogs, Martian serpentinization typically involves more Fe-rich olivine, resulting in correspondingly more Fe-enriched brucite. Throughout these experiments, ferroan brucite demonstrated exceptional reactivity and silica-driven transformation into serpentine, which acts as a potential sink for ferric iron and a source of hydrogen. This mechanism offers a new perspective on how serpentinization systems such as the Lost City hydrothermal field and the Samail ophiolite sustain hydrogen production and microbial life long after primary olivine consumption. Reactions with Fe-enriched brucite yields potentially larger amounts of hydrogen during silicification, suggesting these secondary reactions may have planetary-scale effects on the evolution of the Martian atmosphere and long-term habitability.