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Redox state of iron in serpentinized harzburgite and dunite from the Samail Ophiolite, Oman

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Exceedingly high concentrations of hydrogen is one of the main characteristics of fluids released from serpentinizing systems. Hydrogen is formed at the expense of water, which oxidizes ferrous iron in the primary silicate minerals olivine and pyroxene. This hydrogen can then reduce carbon dioxide, forming methane. Together, hydrogen and methane constitute an important source of energy for lithoautotrophic microbial communities at serpentinite-hosted hydrothermal vents. Methane is also a strong greenhouse gas, and abiogenic methane formed during serpentinization likely played an important role in early atmospheric evolution on Earth, Mars and other planetary bodies.

Quantifying the production of hydrogen during serpentinization requires knowledge of how much ferrous iron has been oxidized. Using iron redox titrations coupled with major element analyses, we have quantified the Fe^{2+}/Fe^{3+} ratio in drill core samples from the Samail Ophiolite in Oman. The use of redox titrations also permits far more analyses compared to Mössbauer spectroscopy or XANES, due to the drastically lower cost. Analysis of multiple samples from two different OmanDP drill holes (BA3A and BA4A) allows the determination of trends in major element concentrations and iron redox state with depth. Correlation of these data with petrographic observations, as well as shipboard XRD and chemical analyses will also help to reveal trends and their underlying causes.

These data can be used in models of hydrogen and methane generation during serpentinization of the Samail Ophiolite. When combined with iron redox data from other serpentinizing systems, our results will help to improve estimates of the importance of serpentinization-derived hydrogen and methane on a global scale. In turn, our results can help to inform models of atmospheric evolution, and potentially help to constrain secenarios for the emergence of microbial life on Earth and other planetary bodies.