

Effect of pH on Rates of Serpentinization and Hydrogen Production

THOMAS M. MCCOLLOM¹, CHRIS DONALSDON¹, & FRIEDER KLEIN²

¹LASP, University of Colorado, Boulder, USA, mcollom@lasp.colorado.edu; ²Woods Hole Oceanographic Institution

Measured rates of serpentinization from laboratory experimental studies vary by several orders of magnitude at the same temperature depending on reaction conditions [1-6]. However, the fundamental reasons for this large variation remains unclear, making accurate predictions of reaction rates in natural systems problematic. To better understand the affect of different environmental factors on rates and products of serpentinization, we have embarked on a series of laboratory experiments to systematically vary individual reaction parameters and observe their impact on reactions [e.g., 6]. We will report here on experiments examining the affect of pH of reaction rates. In one set of experiments at 200 °C, increasing the starting room-temperature pH in the experiment from ~8 to ~12 resulted in a ~5-fold increase in reaction rates and H₂ generation. In another experiment, injection of alkaline fluid into an ongoing reaction of harzburgite at 230 °C resulted in a >10-fold increase in H₂ generation and overall reaction rate. These and other results indicate that strongly alkaline pH results in much more rapid conversion of ultramafic rocks to serpentine than is observed under more neutral conditions. Among the possible reasons for the faster rates is enhanced solubility of Si at higher pH or a change in surface chemistry that allows Mg and Si to be more readily dissolve. As a consequence of the faster rates, the transition from circumneutral to strongly alkaline conditions in low-temperature natural serpentinites is likely a critical factor in controlling the extent of reaction and H₂ generation.

- [1] Martin B. and Fyfe W.S. (1970) *Chem. Geol.* **6**, 185-202.
[2] Wegner W.W. and Ernst W.G. (1983) *Am. J. Science* **283-A**, 151-180. [3] Malvoisin et al. (2012) *J. Geophys. Res.* **117**, B04102. [4] Lafay et al. (2012) *J. Crystal Growth* **347**, 62-72. [5] Andreani et al. (2013) *Am. Mineral.* **98**, 1738-1744.
[6] McCollom et al. (2016) *Geochim. Cosmochim. Acta* **181**, 175-200.