Low-Temperature Serpentinization Produces Abundant Hydrogen Within the Temperature Limits of Life

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Tectonic forces expose mantle peridotite to seawater along mid-ocean ridges, at magma-poor continental rifted margins, and in subduction zones with remarkable implications for life in seafloor environments. Despite increasing interest in peridotite-seawater interactions (i.e. serpentinization), the underlying mechanisms remain grossly under-characterized, particularly at temperatures lower than 200°C. Moreover, the pathways of serpentinization are incredibly variable and remain in many cases difficult to reconstruct. We have examined partly to completely serpentinized peridotites recovered during the Ocean Drilling Program and find a remarkable variation in the abundance of magnetite. Some completely serpentinized peridotites from the Mid-Atlantic Ridge have more than 6 wt% magnetite, whereas others from the Iberia Margin are nearly magnetite free (<0.04 wt%). Using isotopic, magnetic, and thermodynamic constraints, our study reveals a simple link between the abundance of magnetite, the Fe content of brucite, and serpentinization temperature. Samples with abundant magnetite have Fe-poor brucite and were altered at temperatures of 200–300 °C, whereas magnetite-poor samples are associated with Fe-rich brucite and were altered at temperatures <~200 °C. We demonstrate that, despite the small amounts of magnetite present in some serpentinites, abundant hydrogen is generated through Fe(III) hosted in serpentine, lending support to the idea that low- to moderate-temperature serpentinization can generate abundant hydrogen within the temperature limits of life.