

# Stable isotope thermometry and fluid tracing in serpentinites: Insights from SIMS studies

MARIA ROSA SCICCHITANO

University of Wisconsin-Madison, GFZ German Research Centre for Geosciences

Presenting Author: [maria.rosa.scicchitano@gfz-potsdam.de](mailto:maria.rosa.scicchitano@gfz-potsdam.de)

Oxygen isotopes are extensively used as geothermometers and tracers to retrieve temperatures and fluid sources during peridotite hydration and carbonation in various tectonic settings. The accuracy of such estimates depends, however, on the ability to measure oxygen isotope ratios at the appropriate scale of equilibration and on the accuracy of calibrations for oxygen isotope fractionation between serpentine and water, which disagree by up to 20 ‰ when extrapolated to  $T < 200$  °C [1-5].

Recent advancements with Secondary Ion Mass Spectrometry (SIMS) provide a powerful tool for more accurate reconstructions of temperature-fluid histories in serpentinites with complex textures and multiple mineral generations [6]. SIMS allows measuring accurately oxygen isotopes in serpentine and co-crystallized minerals at scales  $\leq 50$   $\mu\text{m}$  as well as identifying systematic zoning in  $\delta^{18}\text{O}$  values, which can be concealed by conventional bulk analysis. Isotope data are directly linked to textural and petrographic observations, and alteration temperatures and water  $\delta^{18}\text{O}$  values for multiple alteration stages can be constrained independently [7]. If the crystallization temperature is constrained petrologically or through clumped isotope thermometry, SIMS analysis of oxygen isotopes in serpentine and co-crystallized minerals allows constructing an empirical calibration for oxygen isotope fractionation between serpentine and water. This approach was recently used to better constrain oxygen isotope fractionation between serpentine and water at  $T < 100$  °C, improving applications of oxygen isotope thermometry and fluid source characterization during low- $T$  serpentinization [8].

More accurate reconstructions of temperature-fluid histories in serpentinites are crucial for better understanding processes associated with hydration and carbonation of ultramafic rocks such as hydrogen production,  $\text{CO}_2$  sequestration and the support of microbial activity.

[1] Wenner & Taylor (1971), *Contrib. Mineral. Petrol.* 32, 165-185

[2] Savin & Lee (1988), *Rev. Mineral.* 19, 189-223

[3] Zheng (1993), *Earth Planet. Sci. Lett.* 120, 247-263

[4] Früh-Green et al. (1996), *Proc. Oc. Dril. Prog.* 147, 255-291

[5] Saccocia et al. (2009), *Geochim. Cosmochim. Acta* 73, 6789-6804

[6] Scicchitano et al. (2021), *Geostand. Geoanal. Res.* 45, 161-187

[7] Scicchitano et al. (2022), *Geochim. Cosmochim. Acta* 318, 144-164

[8] Scicchitano et al. (in-press), *Geochim. Cosmochim. Acta*