Oxygen isotopic disequilibrium *vs.* equilibrium in subducted serpentinites (Zermatt-Saas unit and Erro-Tobbio unit)

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During subduction of serpentinites the dehydration-reaction of brucite + antigorite forms metamorphic olivine, aqueous fluid and minor chlorite. In the Zermatt-Saas unit and in the Erro-Tobbio unit this reaction occurs at eclogite facies conditions (ca. 2.5 GPa and temperatures between 550–600 °C (Kempf *et al.*, 2020 and Hermann *et al.*, 2000, respectively). Samples with different degrees of deformation and different modal abundance of metamorphic olivine from both localities were selected for in-situ oxygen isotope measurements by secondary ion mass spectrometry (SIMS). The scope of this study is to distinguish between different olivine and antigorite generations and to determine if they are in isotopic equilibrium at peak conditions, and in turn define the signature of the escaping fluid.

Serpentinites in Erro-Tobbio show textural equilibrium between antigorite and olivine. Their isotopic signature is homogenous with $\delta^{18}O$ of antigorite = 5.7–6.8 ‰ and olivine = 4.1–5.0 ‰. These results indicate that olivine formed during the brucite consuming reaction is in isotopic equilibrium with reacting antigorite considering the conditions of the dehydration-reaction ($\Delta_{Atg\text{-}Ol}$ at 550°C = 1.8–2.3‰).

In the Zermatt-Saas unit, serpentinites show similar textures to the Erro-Tobbio samples, but the isotopic composition of antigorite mostly varies between $\delta^{18}O$ of 5.6–7.3 ‰ whereas olivine mostly ranges from 1.2–2.3 ‰. In 8 out of 11 samples, despite textural equilibrium, antigorite and olivine are not in isotopic equilibrium at peak conditions. Isotopic equilibrium is present only in three samples, where antigorite has $\delta^{18}O$ = 3.9–4.3 ‰. In two samples, a texturally late olivine with higher Mg# has $\delta^{18}O$ = 3.9–5.5 ‰ that is in isotopic equilibrium with the dominant antigorite.

A possible scenario is that isotopic equilibrium was achieved at prograde to peak conditions, but most of the antigorite and part of the olivine (*e.g.*, rims and along fractures) recrystallized during peak to early retrograde conditions, still in the olivine stability field, when an externally derived fluid infiltrated. Another explanation could be that antigorite preserves an inherited isotopic signature acquired during serpentinization and is therefore in most of the samples not in isotopic equilibrium with the products of the metamorphic reaction. In this second scenario, isotopic equilibrium is achieved only in some samples where antigorite locally recrystallized at peak conditions. Modelling is used to evaluate these two possible scenarios. In either case, the fluid released during the antigorite + brucite dehydration reaction would not be in equilibrium with the dominant antigorite in the samples and would have a $\delta^{18}O$ of about 5–6 ‰, as constrained by olivine that forms together with the fluid phase.

Kempf, E.D., Hermann, J., Reusser, E., Baumgartner, L.P., Lanari, P., 2020. The role of the antigorite + brucite to olivine reaction in subducted serpentinites (Zermatt, Switzerland). S*wiss Journal of Geosciences* 113, *16.*

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