

Tracking fluid flow in subducted serpentinites of the Zermatt-Saas HP-ophiolite (Western Alps) using oxygen isotopes

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Different temperature and fluid conditions during oceanic hydration of ultramafic rocks lead to variable trace element concentrations and isotopic compositions in serpentinite. This variability is in turn transferred to the fluid released from dehydrating serpentinites during subduction-related metamorphism. We investigated serpentinites from a continuous, km-scale outcrop between Upper- and Lower Theodulglacier (UTG and LTG) within the Zermatt-Saas HP-ophiolite that underwent the brucite + antigorite dehydration reaction at 2.5 GPa and 550–600 °C [1]. We measured in situ trace elements and oxygen isotopes in antigorite and olivine to identify differences in the initial serpentinitization setting and to investigate isotopic (dis)equilibrium between antigorite and metamorphic olivine. Measurements in antigorite revealed two distinct serpentinitization settings for UTG and LTG. The volumetrically dominant UTG has low As and Sb concentrations in antigorite and exhibits a range of ¹⁸O values from ~ 4 to 6 ‰. The variability is interpreted as changing temperature conditions during serpentinitization, probably close to the spreading centre in the Piedmont-Ligurian ocean. The volumetrically smaller LTG has higher As and Sb concentrations in antigorite and is dominated by relatively high ¹⁸O (~ 6–7 ‰). This is interpreted as serpentinitization at lower temperature conditions, probably closer to the trench, with possible influence of an evolved fluid. Different serpentinitization settings are further supported by different ¹¹B signatures in antigorite for the two sites (~ 14 and 2 ‰, respectively).

Despite the geochemical and isotopic differences in antigorite, olivine has a homogeneous ¹⁸O over the km-scale with values of ~ 1–2 ‰, with the exception of some high ¹⁸O of ~ 4 ‰ for UTG. It follows that antigorite and olivine are in isotopic equilibrium at UTG and this is interpreted to indicate in-situ production of olivine and fluid in a closed system. On the other hand, the isotopic disequilibrium between antigorite and olivine at LTG is interpreted as olivine formation in an open system induced by external fluids probably originating from UTG.

REFERENCES

[1] Kempf, E. et al., 2020: The role of the antigorite + brucite to olivine reaction in subducted serpentinites (Zermatt, Switzerland). *Swiss J Geosci*, 113,16.