Copper mobilisation and isotope fractionation during subduction

HEYE FREYMUTH[1], HELEN WILLIAMS[1], FRANCES JENNER[2], BAPTISTE DEBRET[3]

[1]Department of Earth Sciences, University of Cambridge, Downing Street, Cambridge, Cambridgeshire, CB2 3EQ, United Kingdom, hf325@cam.ac.uk

[2]School of Environment, Earth and Ecosystem Sciences, The Open University, Walton Hall, Milton Keynes, MK7 6AA, United Kingdom

[3]Department of Earth and Environment Sciences Université Libre de Bruxelles, 50 Avenue F.D. Roosevelt, B-1050 Bruxelles, Belgium

Subduction zones are key components of global geochemical cycles. Fluids released from subducted slabs generate arc magmatism and carry an elemental budget into the mantle wedge that is consequently not subducted into the deeper mantle alongside the residual slabs, thus affecting the surface to mantle mass balance. The fluids also appear to be oxidising [1]. Yet how and where the oxidising properties are attained has so far been largely speculative. Potential oxidising agents transported by slab-derived fluids include sulfate, carbonate, and Fe3+ [e.g. 1,2].

The dehydration of serpentinites underneath the subducting mafic oceanic crust has been suggested as a major source of H2O in subduction zones [3]. We explore whether the oxidizing properties of slab fluids are related to the dehydration of serpentinites or generated at a later stage as the fluids pass through the mafic crust, subducted sediments, and the sub-arc mantle. For this purpose, we focus on Cu isotope ratios and chalcophile element concentrations in serpentinites from the Western Alps [4]. Our samples represent various stages of prograde metamorphic reaction and slab devolatilisation from the replacement of lizardite by antigorite to the first stages of serpentinite dehydration at eclogite facies.

Copper concentrations in the serpentinites decrease by about 50 % from ~16 ppm to ~8 ppm with increasing degree of metamorphism, indicating that Cu is affected by open system processes during devolatilisation. The loss of Cu from the slab is consistent with earlier studies suggesting the mobilisation of Fe and Zn with associated isotope fractionation [5,6] and highlight the significant mass transfer of compatible and chalcophile elements from subducted serpentinites during devolatilisation.

[1] Kelley and Cottrell (2009) Science 325, 605-607, [2] Evans et al. (2012) Geology 40, 783-786, [3] Ulmer and Trummsdorff (1995) Science 268, 858-861 [4] Debret et al. (2013) Chemical Geology 357, 117-133 [5] Debret et al. (2016)

Geology 44, 215-218 [6] Pons et al. (2017) Nature Communications 7, 1-8