

Deep subduction of continental crust contributes to mantle metasomatism and deep carbon cycle

Alessia Borghini¹, Gautier Nicoli¹, Silvio Ferrero^{2,3}, Patrick J. O'Brien¹, Oscar Laurent^{4,5}, Laurent Remusat⁶, Giulio Borghini⁷, and Sula Milani⁷

¹Institut für Geowissenschaften, Potsdam Universität, Potsdam-Golm, Germany (borghini@uni-potsdam.de; nicoli@uni-potsdam.de; obrien@uni-potsdam.de)

²Dipartimento di scienze Chimiche e Geologiche, University of Cagliari, Monserrato, Italy (silvio.ferrero@unica.it)

³Museum für Naturkunde (MfN), Leibniz-Institut für Evolutions-und Biodiversitätsforschung, Berlin, Germany

⁴Eidgenössische Technische Hochschule, ETH, Zürich, Switzerland (oscar.laurent@get.omp.eu)

⁵CNRS, Observatoire Midi-Pyrénées, Géosciences Environnement, Toulouse, France

⁶Museum National d'Histoire Naturelle, Paris, France (laurent.remusat@mnhn.fr)

⁷Dipartimento di Scienze della Terra „Ardito Desio“, Università degli Studi di Milano Statale, Milano, Italy (giulio.borghini@unimi.it; sula.milani@unimi.it)

The garnet in the ultra-high pressure (UHP) eclogites of the Erzgebirge (Bohemian Massif, Germany) trapped primary inclusions of metasomatic melt originated by the partial melting of the continental crust. The study of these inclusions allow us to estimate the contribution of the subducted continental crust to mantle metasomatism and deep carbon fluxes. The inclusions are randomly distributed in the inner part of the garnet, they are micrometric and occur as both polycrystalline, i.e. nanogranitoids, and glassy, often with a shrinkage bubble. Nanogranitoids consist of kumdykolite, quartz, kokchetavite, biotite, white mica, calcite and rare graphite. The inclusions share their microstructural position in the garnet with inclusions of polycrystalline quartz interpreted as quartz pseudomorph after coesite that indicate the entrapment at UHP conditions. The melt composition, measured on glassy inclusions and rehomogenized nanogranitoids, is granitic. The melt is also hydrous, slightly peraluminous and the trace element enrichments observed are consistent with an origin from the continental crust, testified by the high amount of incompatible elements such as Cs, Pb, Th, U, Li and B. Similar signatures were also reported elsewhere in the Bohemian Massif, e.g. in other metasomatic melts hosted in HP mantle eclogites, in metasomatized mantle rocks and in post-collisional ultrapotassic magmatic rocks, suggesting that mantle metasomatism from melts originated in the continental crust is widespread in the orogen.

The melt H₂O and CO₂ contents were measured with the NanoSIMS. The CO₂ values in particular were corrected reintegrating the vapor contained in the shrinkage bubble and are in average 19552 ± 772 ppm, the highest content of CO₂ measured so far in crustal melt inclusions. The modelled endogenic carbon flux associated with the subduction of the continental crust of the Variscan Orogenic Cycle is 22 ± 8 Mt C yr⁻¹. This flux within error is similar to the endogenic carbon fluxes in the serpentinized mantle (~ 14 Mt C yr⁻¹) and to the exogenic fluxes in mid-oceanic ridges (~ 16 Mt C yr⁻¹) and arc volcanoes (~ 24 Mt C yr⁻¹). Hence, in collisional settings, deeply subducted continental crust carried a large amount of volatiles to the mantle and the lower crust. Due to the absence of post collisional arc volcanism, most of these volatiles remained trapped in the root of mountain belts. This long-term storage of the carbon in the orogen roots prevents ultimately the closure of the carbon cycle.