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Arrested decarbonation in an ancient subduction zone: Isotopic and petrographic evidence from HP/UHP meta-ophiolitic breccias in the Western Alps

JUAN FELIPE BUSTOS MORENO[1], TIFFANY BAUMANN[1], GRAY E. BEBOUT[1] AND SAMUEL ANGIBOUST[2,3]

[1]Lehigh University
[2]IPG Paris
[3]Ecole Normale Supérieure of Lyon, Lyon University

Presenting Author: jub221@lehigh.edu

We examined exposures of meta-ophiolitic breccias from the French/Italian Alps that experienced peak *P-T* conditions (1.0–2.4 GPa; 300–550 °C) similar to those encountered in some modern subduction zones, with the goal of assessing degrees of carbon (C) loss via decarbonation reactions. The targets were contacts of clasts with carbonate cement at which calc-silicate phases growing as reaction rims could reflect decarbonation driven by interaction with H_2O-rich fluids. A field, petrographic and isotopic approach for two of six localities studied thus far provides hints of such decarbonation. Carbonate C-O isotope data (87 microdrilled samples) for Lago Nero (LN) and Ubaye Valley (UV) suggest interaction with low-$\delta^{18}O$ (likely H_2O-rich) fluids as evidenced by $\delta^{18}O_{VSMOW}$ shifts toward (~ +14‰) from values for ocean-floor protoliths (~ +30‰). These shifts are consistent with interactions with fluids from mafic and ultramafic sources [1]. A subset of samples from UV falls toward higher $\delta^{18}O$ and much lower $\delta^{13}C$, showing a trend consistent with interaction with fluids from nearby calc-schists [2]. The array of C-O isotope values for LN resembles a Rayleigh fractionation trend, perhaps an aggregate result of precipitation from H_2O-rich fluids containing C released during decarbonation over larger volumes in the slab/interface section. Both localities show modest mineralogical evidence of decarbonation as reaction rims at the carbonate-silicate contacts, with pumpellyite, clinozoisite/epidote, and Ca/Na-amphiboles at metabasaltic clast rims at UV and tremolite/actinolite crystallized at rims of ultramafic clasts at UV and LN. These reaction rims are abundant but fine-grained (thicknesses of 20-200 μm), thus providing evidence of decarbonation insufficient to shift cement $\delta^{13}C$ to lower values except at very local scales. Additional thermodynamic modeling (PERPLE_X) will reveal whether the calc-silicate phases observed are plausibly the results of decarbonation reactions produced at/near peak *P-T* by interaction of H_2O-rich/low-XCO_2 fluids. Thus far, our data suggest that meta-ophiolitic breccias in the Western Alps interacted extensively with H_2O-rich fluids resulting in modest decarbonation and impressive retention of carbonate in such breccias to depths of at least ~50km in the forearc.

[1] Jaeckel et al. (2018) Geosphere. 14(6), 2355–2375.

[2] Collins et al. (2015) Chem. Geol. 412, 132-150.