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Olivine-hosted melt inclusion compositions support subducting slab melting under Ecuadorian volcanoes

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The contribution of the different geochemical reservoirs (slab-mantle-crust) to arc magma genesis is a long-lasting discussion of the scientific community. The role of deep process (slab-mantle) is difficult to constraint because arc magmas, since their formation in the mantle wedge, change their composition by crustal processes such as melting, assimilation, storage, homogenization and fractional crystallization. The adakite-signature (i.e. high Sr/Y and $(La/Yb)_N$) and high Th/Nb and Th/La of magmas from the Ecuadorian segment of Northern Andean Volcanic Zone –Ecuadorian arc– are thought to be inherited from a hydrous siliceous melt slab component (cf. Hidalgo et al. 2007; Samaniego et al. 2010; Ancellin et al. 2017) or from a lower- to mid-crustal processes of mantle metasomatized by -most common- low density aqueous fluids-derived melt (cf. Chiaradia et al. 2009; 2011). These two contrasted -albeit not exclusive- mechanisms of signature acquisition are not clearly distinguished by whole-rock major, trace or isotopic lava composition studies (e.g. Chiaradia et al. 2014; Ancellin et al. 2017) most probably because sampled lavas are even in a small degree, affected by crustal processes.

We present new analysis of major, trace and volatile elements of a group of relatively rare melt inclusion (MI) hosted in primitive olivines from the Ecuadorian arc that sits upon a ~50 km-thick crust. The new MIs come from Cotacachi, Cubilche and Sangay volcanoes, as well as Tulabug and Cono de la Virgen cones. These MIs display ultrabasic to basic compositions (42.0-51.8 wt.%. SiO_2) and fall in the field of basalts, trackybasalts and tephrite basanites in the TAS diagram. MIs from CLV have high- Th/La (up to 3.2) and La/Nb (up to 15.5) similar to lavas resulted from interaction between primary mantle-derived magmas and crustal rocks, even though, they are hosted in mantle olivines (Fo_{88-90}), which means they were trapped before any crustal process could modify their composition. This evidence, at least for MI compositions, that such signatures are not acquired by intracrustal magmatic processes but that are most likely transferred by material coming from the subducting slab.

On the basis of trace elements, we recognize two different slab components added to the mantle wedge below the Ecuadorian arc. One that is rich in fluid-mobile (Ba/La: 30-110 and Pb/Ce: 0.1-0.5, B/Nb: up to 22) and poor in fluid-immobile elements (La/Nb: 2.2-4, Th/Nb: up to 0.7) observed everywhere, except for MIs coming from CLV. The second, only observed in CLV and previously reported by Narvaez et al. (2018) in olivine- (Fo_{82-86}) hosted MIs from Puñalica volcano, that is relatively enriched in fluid-immobile elements (La/Nb:7.2-15.5, Th/Nb: up to 3.2) and has low fluid-mobile elements contents (Ba/La: 15-36 and Pb/Ce: 0.02-0.1, B/Nb: up to 4.4). Using Arc Basalt Simulator 3 spreadsheet (Kimura et al. 2010), we found that the first group of MI (from Cotacachi, Cubilche, Tulabug and Sangay) compositions are consistent in trace elements with the addition of 2-5 mass% of an aqueous fluid-like slab component to the mantle wedge, and the second group (CLV and Puñalica) by the addition of 10-20 mass% of a hydrous siliceous melt.