Arc-like magmas and pyroxenites generated by mélange-peridotite interaction in the mantle wedge

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In subduction zones, the mechanisms of transfer of volatiles and crustal material from the subducting slab to the overlying mantle wedge are still debated. In recent years, it has been postulated that mélange rocks, which are physical mixtures of sediments, oceanic crust and ultramafic rocks formed along the slab-mantle interface, could play a key role in arc magmatism. In addition, numerical studies predict that buoyant melange diapirs may rise from the slab-mantle interface and interact with the overlying mantle wedge, which has profund implications for subduction zone dynamics and transfer of volatiles from the subducting slab to the overlying mantle wedge. In that scenario, mélange material could mix with and hybridize the peridotite mantle wedge, and participate in the generation of arc magmas. However, limited data exist on the composition of partial melts generated by a hybrid mélange-peridotite source, and how those melts would compare to natural arc lavas.

Here, we have experimentally investigated the composition of melts produced during partial melting of natural mélange-peridotite hybrid materials using piston cylinder device at 1.5 GPa and 1280–1350 ºC, relevant to the hot zones of the mantle wedge. We performed the experiments using natural peridotite powders and 5 to 15 % by volume of two natural end-member compositions of mélange rocks. We analyzed glassy melt pools (~5 % by volume) that have approached equilibrium with the residual solid by EPMA, LA-ICP-MS and SIMS. We show that the major- and trace-element compositions of experimental melts produced by partial melting of mélange-peridotite hybrid materials broadly resemble natural arc lavas and display their characteristic arc signature (i.e., enriched LILE and depleted HFSE). Our results also indicate that orthopyroxene-rich pyroxenites would form as a result of melt-rock reaction within the mantle wedge. Thus, we argue that mélange may play a prominent role in transferring volatiles, alkali, and characteristic subduction signatures from the slab to the source of arc magmas.