Generation of arc-like magmas by mélange-peridotite interaction in the mantle wedge

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In subduction zones, the mechanisms of transfer of volatiles and crustal materials from the subducting slab to the overlying mantle wedge are still debated. Recently, it has been argued that mélange rocks, which are physical mixtures of different lithologies (e.g., metasediments, eclogites, serpentinites) formed from deformation-assisted mixing and fluid-rock interactions along the slab-mantle interface, could migrate from the slab-top to the overlying mantle, and transfer their compositional signatures to the source region of arc magmas. However, the compositions of melts that would result from the interaction of mélange rocks with the peridotite mantle wedge remains unknown. Such information is critical to determine whether mélange rocks are viable contributors to arc magmatism worldwide.

To examine this, we experimentally investigated melting of natural peridotite-mélange hybrid materials using a piston cylinder device at 1.5 GPa and 1150–1350 ºC and simulated a scenario where mélange materials rise as a bulk into the hot corner of the wedge and homogenize with the peridotite. We performed the experiments using natural DMM-like peridotite (95–85 vol. %) mixed with limited volumes (5–15 vol. %) of two natural end-member compositions of mélange rocks. Here we show that melting of peridotite hybridized by limited volumes of mélange rocks produces melts that carry the major and trace element abundances, and fractionated trace element ratios characteristic of natural arc lavas. We discuss how the differences in the nature/type and relative contributions of mélange material assimilated into the mantle wedge can result in the formation of compositionally diverse primary arc magmas, ranging from arc tholeiites to calc-alkalines. Thus, we argue that the ascent and assimilation of mélange material into the mantle wedge may play a key role in transferring materials and characteristic subduction signatures from the slab to the source of arc magmas