Melt-peridotite reactions in a veined mantle: pyroxenite-peridotite experiments at 2 GPa

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Pyroxenite-derived partial melts reacting with peridotite modify mantle sources by creating hybrid rocks, i.e. refertilized peridotites and secondary-type pyroxenites. We experimentally investigated the reaction between a fertile lherzolite and partial melts produced by an olivine-free pyroxenite at 2 GPa. Melting behaviour of garnet websterite Px-1 (e.g. Sobolev et al., 2007) has been firstly derived. Px-1 starts to melt just below 1280°C, and it mostly produces MgO-rich basaltic andesites. Garnet and clinopyroxene are progressively consumed by melting, and orthopyroxene is the liquidus phase. Our reaction experiments juxtaposed pyroxenite Px-1 on a powdered, previously sintesized, fertile lherzolite providing a direct comparison between the modal and mineral compositions in the fertile lherzolite and in the peridotite modified after reaction with pyroxenite-derived melt. At 1300 and 1350°C, partially molten pyroxenite interacts with the subsolidus lherzolite producing a thin (about 50-100 μm) orthopyroxene-rich reaction zone at the pyroxenite-peridotite interface. Chemical profiles along the capsules show that X_{Mg} and Cr_2O_3 content in pyroxenes decreases, and TiO_2 increases, across the pyroxenite-peridotite boundary, with intermediate values in the reaction zone. Remarkably, in the subsolidus lherzolite spinel records X_{Mg} and X_{Cr} decrease and TiO_2 increase going toward the molten pyroxenite, with spinel X_{Cr} variation increasing with temperature. Similar chemical gradients are observed in some natural pyroxenite-peridotite sequences. Experimental results suggest that element diffusion across the two starting layers is able to modify the mineral chemistry of subsolidus peridotite. At 1380-1400°C, pyroxenite-peridotite interaction resulted in a larger melt-bearing websterite layer (about 650 μm). Relatively high-TiO_2 contents in pyroxenes and spinel suggest that pyroxenite-derived melt percolated into the peridotite layer profiting of porosity created by low-degree of peridotite partial melting. At 1450°C, pyroxenite is almost completely melted. Fluxing of pyroxenitic melt into molten peridotite further enanches peridotite melting creating a melt-bearing dunite associated to a refractory harzburgite.

Sobolev A. et al. (2007): The amount of recycled crust in sources of mantle-derived melts. Science, 316, 412-417.