Formation of orthopyroxenite-dunite assemblage by hydrous melt-peridotite interaction: An experimental study

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Orthopyroxenite is observed as dikes in dunite in the mantle sections of ophiolites. It also forms composite xenoliths with dunite brought to surface or near surface by basalts or diorites. Formation of this seemingly incompatible lithological assemblage is often attributed to interaction between hydrous (siliceous) melt and peridotite. To better understand the mechanism of hydrous melt-peridotite interaction and its role on the formation of orthopyroxenite-dunite assemblage, we conducted melt-rock reaction experiments by juxtaposing a layer of dunite or lherzolite against a layer of hydrous basaltic andesite (0.5 or 4 wt% H_2O) in Au-Pd capsules. The experiments were run at 1200°C and 1 GPa for 3-12 hrs. In all the experiments, an orthopyroxene reactive boundary layer was formed, but its texture and thickness are different depending on water content in reacting melt. In the 0.5% water-bearing melt and dunite reaction experiment, the orthopyroxene layer is thin (<15 μm at 12 hr) and nearly impermeable. In the 4% water-bearing melt and dunite reaction experiments, the orthopyroxene layer has a larger grain size and porosity, hence permeability. Thickness of the orthopyroxene layer is 70 μm at 3 hr and 120 μm at 12 hr. In the 4% water-bearing melt and lherzolite reaction experiment, similar orthopyroxene + melt layer was formed with the lherzolite transformed into a pyroxene-free dunite. This orthopyroxene layer (130 μm at 3 hr) is thicker than that from the dunite dissolution experiments.

Our results underscore the importance of water content and water infiltration in controlling the kinetics of hydrous melt-peridotite interaction and the style of hydrous melt transport in the mantle. Sufficient water in melt is required to form of high-porosity orthopyroxenite channels in the mantle. Partial melting of ambient peridotite triggered by water infiltration facilities the development of orthopyroxenite channel, and water loss likely causes its closure.

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