Melt impregnation and reaction processes in the upper mantle: An experimental investigation.

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Melt-rock interaction processes are known from a variety of ultramafic rocks (e.g. plagioclase peridotite, dunite channels) exposed in ophiolite complexes and are crucial for our understanding of crust-forming processes. The rationale of this experimental study is to derive a consistent set of data to evaluate the compositional and time-dependent evolution of migrating magma over a range of temperatures and pressures as a function of initial melt and peridotite composition.
To simulate melt-peridotite reaction processes we perform nominally dry experiments with a 3-layered setup: a bottom layer of diamond or vitreous carbon powder (serving as a melt trap) overlain by a layer of peridotite and on top a layer of olivine tholeiite powder (the “melt”). The peridotite layer, with variable modal compositions and grain sizes, is synthesized by mixing hand-picked grains from a Balmuccia peridotite sample (orthopyroxene, clinopyroxene and spinel) and San Carlos olivine. The 3-layer setup is contained in a graphite capsule sealed by a tight-fitting lid and places into an outer Pt-capsule that is welded shut. The inner graphite capsule minimizes Fe loss to the noble metal capsule and constrains the fO_2 at the C-CO_2-CO equilibrium. Experiments are performed on a Boyd-England type solid-media piston cylinder apparatus using NaCl-pyrex-MgO assemblies. A friction correction of ~3% is applied to the nominal pressure and temperature is measured with B-type thermocouples with an estimated accuracy of ±10°C.
A first series of experiments has been conducted with peridotite powder of variable grain sizes, spanning a temperature range of 1200 to 1320°C at a constant pressure of 8 kbar. At 1320 and 1290°C, spinel and pyroxenes are completely dissolved and olivine is newly formed in the peridotite layer. At 1260°C and all lower temperatures, the pyroxenes and spinel become stable, as testified by their growth in the melt and peridotite layers. At 1200°C we observe the first occurrence of plagioclase (An_{47-61}). As a result of crystallization and interaction with the pre-existing mineral phases, the melt composition changes significantly and is different in the melt trap and the original melt layer. The most important changes related to melt flow through the peridotite layer are enrichment in silica and alkalies.