Granite melt convecting in an experimental micro-magma chamber at 1050 °C, 15 kbar

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Abstract: Equal masses of powdered granite and serpentinized peridotite packed into gold capsules with the materials separated by a sharp vertical boundary were held for between 0 minute and 11 hours at 1050 °C, 15 kbar to investigate contamination of hydrous granite melt by reaction with ultramafic rocks, as might occur near the crust-mantle boundary. The shorter duration runs show a melting front advancing from the vertical granite-peridotite boundary, where water is released from serpentine dehydration in the peridotite. The rate of advance of the melt front decreases from over 10^{-4} cm/s in the first minutes to less than 10^{-5} cm/s after 1 hour, suggesting that water diffusion to the melting front controls the melting rate. Experiments of longer duration show evidence of convective flow of the granitic melt, and the flow features defined by graphite distributed in glass develop continuously with time. A 7-hour run shows a small concentration of residual quartz and feldspar at the far end of the capsule, with trails of graphite and entrained crystals tracing flow lines from the crystal-rich area towards the center of the peridotite boundary, then around in a near-circular swirl in the lower half of the capsule. The graphite forms by reduction of the small amount of CO_{2} in the starting materials. Glass analyses reveal initial steep compositional gradients adjacent to the peridotite (e.g. up to 2 wt.% MgO; 0.1 wt.% in granite initially) but with increasing run duration the gradients become less steep and compositional changes are spread throughout the main body of melt. After 11 hours, the granite is completely melted, graphite which traced flow patterns in shorter runs has disappeared (presumably due to oxidation), and the granite is similar in composition to the starting material; the most notable changes are an approximately 1.0 wt.% increase in MgO (0.1 wt.% initially), 0.4 wt.% increase in FeO (from 0.64 wt.% initially), and less than 1 wt.% decreases in Al_{2}O_{3} and SiO_{2}. The driving forces for the observed flow are not known but the most likely explanations involve a small horizontal temperature gradient and/or small variations in melt water content.

Key-words: experimental petrology, convection, contamination.

Introduction

We have conducted a series of experiments designed to explore the effects of contamination of silicic magmas by mafic and ultramafic materials at various locations between subducted oceanic crust and the shallow plutonic environment of the continental crust (Wyllie et al., 1989). Among these experiments is a design with H_{2}O-undersaturated granitic melt adjacent to crystalline or partly melted peridotite. Sekine & Wyllie (1983) studied such reaction couples at 30 kbar, simulating the escape of hydrous silicic magma from subducted oceanic crust into overlying mantle peridotite. They completed experiments with three geometries, mainly at temperatures below the peridotite solidus: (1) with the peridotite above the granite melt, (2) with the peridotite alongside the granite melt so that the boundary was vertical, and (3) with a layer of granite melt sandwiched between two lateral layers of peridotite (verti-