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SPECIAL COLLECTION: DYNAMICS OF MAGMATIC PROCESSES

Water transfer during magma mixing events: Insights into crystal mush rejuvenation and melt extraction processes

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Abstract

Many plutons preserve evidence of magma mixing between hydrous mafic magmas and resident felsic crystal-rich mushes. To investigate water transfer processes in such systems following thermal equilibration, we conducted 24 h experiments to establish the petrological evolution of a water-undersaturated (4 wt% H_2O in the interstitial melt) quartz-bearing dacite crystal mush (0.5–0.8 in crystal fraction) intruded by a water-saturated (≥6 wt% H_2O), initially crystal-free, andesite magma at 950 °C and 4 kbar (12 km depth). Our results show isothermal undercooling resulting from a change in liquidus temperatures of the interacting magmas due to their changing water content. Specifically, mafic samples dramatically crystallize during water escape into the felsic end-members and consequent increase in liquidus temperature. Conversely, the addition of water to the felsic mush reduces the liquidus temperature, leading to an increase in melt fraction. The experiments provide insights into how volatiles contribute to crystal mush rejuvenation (i.e., increase of melt fraction). However, H_2O diffusion alone is not sufficient to promote melt extraction from short- and long-lived mushes in the Earth's crust.

Keywords: Magma, mixing, mafic, felsic, mush, water, diffusion, undercooling