Timescales and physical limitations for magma mixing at arc volcanoes

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Mixing of mafic and felsic magmas is a process commonly invoked to form intermediate composition magmas at stratovolcanoes [1]. However, significant barriers to mixing, such as viscosity contrast and thermal differences, may inhibit the efficient mixing of mafic and felsic magmas. These barriers may be the reason why current estimates of the timescales of magma mixing span many orders of magnitude, preventing a clear understanding of the process of magma mixing. With good constraints on the heat capacity, viscosity, and proportions of mixed magmas, we may be able to link the timescales of mixing with the different properties of the magmas mixing.

Here we combine textural, geochemical, and crystal size distribution analyses of lavas erupted from Mutnovsky Volcano in Kamchatka with thermodynamic and viscosity models to investigate the mechanisms and timescales of magma mixing as well as physical barriers to magma mixing. We utilize MELTS-modeled thermodynamic parameters with chemical and textural data of plagcioclase phenocrysts to demonstrate that compositionally distinct mafic and felsic magmas with significantly different initial temperatures and viscosities may efficiently hybridize to produce intermediate composition magma. We applied our model to published data for Mount Hood, Oregon, where mixing of basaltic and rhyolitic magma has been invoked to produce andesites [1]. We use the previously calculated volumes of magma mixed, as well as the physical properties of the magmas, combined with diffusion profiles in individual phenocrysts to constrain the residence time of single crystals in the hybridized magma post-mixing. This provides for an opportunity to link the timescales of magma mixing with the compositional disparity of magmas mixed. These methods and results can be applied to arc volcanoes globally where magma mixing has been proposed to determine the longevity of mixed magma chambers and to infer links between magma mixing and eruption.

[1] Kent et al. (2010) *Nature Geoscience* **3**, 631-636.