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Transcrystalline melt migration in clinopyroxene

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Realistic modelling of magma chamber evolution requires quantitative data on the kinetics of crystal nucleation, growth and dissolution. However, the interpretation of classical crystal growth experiments is often hampered by nucleation delay, melt convection, and diffusion. Recent experiments of thermal melt migration through olivine crystals indicate that they may serve to collect basic physicochemical data on crystal growth at low undercoolings (Schiano et al., 2006). Here, we have realized transcrystalline migration experiments of basaltic melt inclusions in clinopyroxenes using a modified microthermometric 1-atm heating stage. The results indicate that transcrystalline migration of melt inclusions in the presence of a thermal gradient occurs in clinopyroxenes at the timescale of our experiments. The direction of migration, as well as the morphological evolution of the inclusion during migration, is largely governed by the host crystallography. In addition, the exsolved gas bubble remains fixed and separates from the melt. Migration occurs by progressive dissolution and crystallization, controlled by interface kinetics with no significant interference of chemical diffusion. The same kinetic law applies to different experimental conditions and different clinopyroxene crystals: $V = k\,\theta\,L$, where V is the migration rate, θ is the thermal gradient, L is the inclusion length, and k is a kinetic constant ($k \approx 0.02$ nm.s^{-1}K^{-1} at $T \approx 1100^{\circ}$C). The mechanism of transcrystalline melt migration and the associated kinetic laws are similar in olivine and clinopyroxene. This gives further support to the hypothesis that transcrystalline melt migration is a general mechanism for the segregation of magma at the grain scale and for fluid inclusion formation.

Ref: Schiano P., Provost A., Clocchiatti R., and Faure F., *Science* 314, 970-974, 2006.