Mixing modifies the crystal record of magmatic evolution

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Near-fractional melting of the Earth's geochemically and lithologically heterogeneous mantle produces diverse primary melt compositions. However, these diverse compositions are frequently homogenised by magma mixing during ascent. Unravelling disequilibrium within and between crystals and their carrier melts provides one way to evaluate the true complexity of melts supplied to the base of crustal plumbing systems. However, crystals are not simply passive tracers of magmatic processes. For example, changing temperature may trigger growth, resorption or diffusive reequilibration depending on the degree of disequilibrium and feedbacks between different kinetic processes. Changes in magma composition also induce changes in crystal cargoes; changing the bulk composition modifies phase equilibria relationships. However, the response of compositionally distinct basaltic magmas (i.e. crystal–melt mixtures) to mixing has yet to be quantified experimentally. To address this, we performed experiments on two primitive Icelandic magma compositions derived from geochemically and lithologically distinct depleted (lherzolitic) and enriched (recycled) mantle sources. Synthesis experiments were performed at 300 MPa and 1190 °C, resulting in different phase assemblages. The depleted composition crystallised ol+plg+cpx (~50% crystals), whereas the enriched composition crystallised only ol+cpx (~20% crystals). Mixing experiments were then performed by placing pairs of quenched magma cylinders into new capsules and performing reequilibration experiments for 1, 4, 8 and 96 hours. Transects across experimental products show that melt compositions underwent diffusive reequilibration, with different elements showing responses commensurate with their different diffusivities. The reequilibration of melt compositions is largely unaffected by the presence of crystals yet exerts a dominant control on crystal stability, with a wave of plagioclase dissolution progressively invading the depleted portion of experimental samples with increasing time. The ability of crystals to record magmatic processes is thus compromised by mixing-triggered dissolution processes. Mixing may therefore modify records of magmatism in important but previously underappreciated ways.