Magma plumbing systems in the Eastern Volcanic Zone of Iceland

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The Eastern Volcanic Zone (EVZ) of Iceland, where the Mid-Atlantic Ridge makes its closest approach to the centre of the Iceland plume, is the most volcanically productive of the island's neovolcanic zones. Over 80% of the eruptions documented since the settlement of Iceland in 874 have an affinity with the EVZ, including the recent eruption of Bárðarbunga-Holuhraun in 2014. The fresh and abundant products of EVZ eruptions offer an excellent opportunity for investiagting models of basaltic plumbing systems. By combining crystal zoning patterns with melt inclusion analyses, major and trace element disequilibrium between discrete crystal assemblages has been identified in the products of numerous EVZ eruptions, including those of the voluminous Laki eruption in 1783. These different assemblages reflect not only mixing between variably evolved magmas, but also between variably enriched primary melts. Correlations between phase proportions, textural propoerties and whole-rock compositions indicate that mixing often takes the form of mush entrainment, which occurs throughout the evolution of magmas. The critical application of thermobarometers based on inclusion entrapment pressures, melt compositions and clinopyroxene-melt equilibria reveals that magma evolution takes place over a wide range of depths in the EVZ. Primitive crystal grow within the mid-crust (2–5 kbar, 8–20 km). In contrast, evolved crystals and crystal rims grow within the shallow crust (0–2 kbar, 0–8 km), where melt and crystals equilibrate for the last time before eruption. It is thus probable that magmas erupted within the EVZ are processed via a large number of vertically stacked magma reservoirs *en route* to the surface. Although magmas are generally homogenised before eruption, their crystal cargoes nonetheless record their assembly from complex mixtures of melts, crystals and mushes. With conceptual models of plumbing system geometries in place, the timescales of some magmatic processes can then be estimated using textural and diffusion modelling approaches. While some crystals record mixing timescales of several months, most record short timescales of days to tens of days that represent the final episode of mixing and mush entrainment before eruption.