The petrological record of magma storage under Iceland and the adjacent spreading ridges

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Thermo-mechanical models of crustal accretion at spreading ridges can be used to make quantitative predictions about the relationship between magma chamber depths of melt fluxes. The spreading ridges in the vicinity of Iceland provide an excellent observational basis for testing such models because they show large variations in melt supply rate and have been the subject of intensive sampling and geophysical campagins. A number of barometric methods based on melt compositions, crystal-melt major element equilibria and volatile element contents, have been applied to these samples.

One method for constraining magma storage depths is based upon a parameterisation of the relationship between pressure and the compositions of basaltic liquids that are in equilibrium with olivine, augite and plagioclase. This OPAM barometry has previously been used to study Icelandic basalts. We show, however, that a mathematical realisation of this barometric method and stringent application of filters for 3-phase saturation substantially modify the recovered pressure estimates. In certain cases, these estimates of magma storage depths are reduced by 3 kbar or more. Such problems with previous applications of the OPAM barometer in Iceland may also have been recapitulated in the global study of MORB storage conditions.

We re-examine the variations in OPAM-derived equilibration depths for a dataset of >3000 glass compositions from Iceland and the surrouding ridges. In regions of Iceland with thin crust and low overall melt supply rates a large range of melt storage depths is recovered, from >20 km to ~4 km. The shallower part of this range matches magma chamber depths estimated from geophysical and geodetic observations in these regions. Parts of Iceland with higher melt fluxes show consistently shallower OPAM-derived storage depths, from 2-5 km, once again corresponding to geophysical estimates of magma chamber depths.