Magmas going through Icelandic crustal filter

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Eruption of large-volume basalts in large igneous provinces and hotspots occurs throughout areas of preexisting thick crust and crust overloaded by early eruptions from the same plume. Iceland represents a good testing ground for estimating the amounts of upper crustal contamination of mantle-derived magma in long-lived propagating rifts - magmatic pipelines going through the isotopically fingerprinted low-$\delta^{18}O$ thick crust affected by rain and glacial meltwaters. We report analyses of individual primitive olivines across Iceland and demonstrate that the Icelandic plume is not severely depleted in ^{18}O neither contains higher than mantle values (5.2-4.6‰ for Ol >Fo_{86}). We observe a positive correlation of Fo and $\delta^{18}O$(olivine) down to Fo_{75} suggesting that crustal differentiation and assimilation is responsible for low-$\delta^{18}O$ evolved olivines and host basalts. We report new data and interpretation of oxygen isotope diversity in olivines from large volume rift basaltic eruptions and investigate in detail olivine-basalt oxygen isotopic equilibria. Up to 3‰ variations of Fo_{75} to Fo_{86} olivines suggest rapid transformation of mantle-derived magmas in the magma plumbing systems. Low- $\delta^{18}O$ values of large volume basalts (e.g. Laki, Veidivotn), with MgO <5wt%, require that tens of percent of a low-$\delta^{18}O$ mafic component was added to normal-$\delta^{18}O$ mantle derived basalt. Only limited $\delta^{18}O$ whole rock heterogeneity is present in large volume basalts suggesting effective mixing and homogenization prior to eruption. Diffusive reequilibraion of disequiibrium olivines and plagioclase require hundreds of years, and their longest residence is in the semi-frozen cumulates underneath volcanoes. Rapid transport along a bifurcating network of dikes and sills inside of the hyaloclastitic upper crust provide a viable mechanism for crystal entrainment and basalt mixing by forced convection. We provide a simple numerical model of this process. We further discuss the effect of flowing basalt in upper crustal lithologies leading to crustal melting and generation of low- $\delta^{18}O$ silicic melts with heterogeneous crystal cargos.

Rhyolites-Hard to Produce, Easy to Recycle: Isotopic diversity in zircons as petrogenetic tool

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Rapid pace of discovery of oxygen isotope diversity in zircons and other minerals in large volume ignimbrites worldwide suggests that this phenomenon characterize many silicic units studied so far by *in situ* methods. We report new results from calderas in the Snake River Plain: Picabo, early Bruneau, in addition to previously reported Yellowstone and Heise), Kamchatka, and rhyolites from rifts of Iceland (Askja, Hekla, Torfajokull). As low-$\delta^{18}O$ oxygen values fingerprint petrogenesis to the upper crust, these observations lead to a model of silicic magma by "double-recycling" of zircon-saturated, silicic to intermediate rocks. Initial melts are produced slowly in diverse batches and the isotopic signature of zircons record their immediate environment of growth. Next, magma batches with diverse zircons merge into larger-volume magma bodies, which mix crystals together and erupt quickly. Concave-up crystal size distributions of zircons and quartz in studied voluminous ignimbrites can be explained by just two episodes of reprecipitation.

Following the melting simulation of [1] we use visco-plastic rheology for surrounding rocks to explain the formation of magma batches generated side by side and merging them together. We observe: 1) Fast convective melting with low heat dissipation. 2) Efficient mixing on large (kilometers) horizontal scales, due to the vigorous flow field induced by compositional convective melting of silicic predecessors by superheated rhyolites. Chaotic, meter-scale vortexes of altering directions cause disintegration of the liquid parcels to diminishing size. The marker method allows us to track particle mixing (i.e., how zircons with diverse isotopic values brought together). 3) Mechanical interaction of the closely-spaced sills in hot visco-plastic upper crust with low yield stress (<100 MPas) leads to mechanical failure (both brittle and plastic) of separating screens leading to the coalescence of sills into a single body. We suggest that analogous processes of rapid two-stage segregation may characterize granitic batholith, and large supervolcanic magma bodies formed by remelting.

[1] Simakin A., Bindeman I., 2012, EPSL, 337-338, **224**.

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