Determination of end-member proportions for syn-eruptive magma mixing of 2010 Eyjafjalljökull eruption by high-resolution geochemical mapping of volcanic ash

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The April–May 2010 eruption of the Eyjafjallajökull volcano (Iceland) has become a benchmark for the understanding of ash-dominated eruptions. In this work we investigated volcanic ash collected at different locations during the terminal stage of the eruption (18.-23.05.10). The compositional variability of glass compositions, based on 771 data points on 27 samples, claims for syn-eruptive magma mixing. The glasses show continuous evolving trends from trachyandesite to rhyolite (57.13-70.78 wt.% SiO_2). Compositional histograms of MgO, FeO, SiO_2 and CaO show two populations of concentrations, while Na_2O, Al_2O_3 and K_2O display a single bell-shaped pattern. Numerical simulations of chaotic magma mixing have been performed. Results indicate that the initial stages of magma mixing are dominated by the presence of two compositional populations that, with the passing of time, merge into a single bell-shaped pattern, as for the natural samples. The maximum of the single bell-shaped pattern corresponds to the hybrid composition. In addition, at the same time, while the slow diffusing elements show two compositional populations, the fast diffusing ones display a single peak. Comparing our simulations with natural data we infer that, as Na_2O, Al_2O_3 and K_2O show a single compositional peak, they provide indication about the hybrid composition. Based on the classic two end-member mixing equation we estimated that the initial fractions of end-members were of the order of 0.5 felsic and 0.5 mafic. In conclusion, we show that the combination of high-resolution geochemical mapping of volcanic ash and numerical simulations can provide unprecedented information about end-members fractions. This is essential in order to constrain eruption dynamics and the kinetics of syn-eruptive mixing. Trace element determinations are in progress and will provide stronger constraints about the envisaged processes at Eyjafjallajökull volcano during the 2010 eruptive activity.