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Decoding fractional crystallization and internal magma mixing processes in magma chamber of the Bezymianny Volcano, Kamchatka

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Our new dataset for whole-rock and phenocryst major, trace and isotopic compositions indicate a genetic link between andesites of the recent to Holocene eruptions of the Bezymianny stratovolcano, the andesitic to dacitic Late Pleistocene lava dome complex and magnesian to high-alumina basalts of the adjacent Kliuchevskoi Volcano. We demonstrate that volcanic products of the recent and some prehistoric eruptions are most likely the products of magma mixing between silicic products of the earliest stages of magma fractionation and the less evolved basaltic andesite parental melts periodically injected into the magma reservoir. Intermediate and silicic magmas of the most prehistoric eruptions of the Bezymianny Volcano and lava dome complex together with basalts from Kliuchevskoi Volcano much closely resemble the liquid line of descent and can represent unique prolonged and continuous calc-alkaline trend of the magma evolution from high-magnesian basalt to dacite. As a result of the geothermobarometry, we recognize distinct and variable conditions of magma fractionation and magma storage beneath Bezymianny Volcano for different magma types during its evolution since the Late Pleistocene.

The crystallization sequences of a parental basaltic andesite of Bezymianny Volcano is simulated experimentally at 100 and 700 MPa at various water activities to constrain the stability fields of mineral phases and to investigate the compositional evolution of residual liquids. Our new experiments allows us to bracket the conditions of magma storage of Bezymianny parental magma. It is most probably located in the upper crust at depths of $\sim$15 km at $\sim$1110 °C. The parental magma should have $\sim$2 wt% H_2O to be saturated with Plag+Cpx+Opx$\pm$Mt – the typical mineral assemblage of the basaltic andesites and their evolutionary products mainly composed of two-pyroxene andesites. The subsequent evolution of this parental magma continues during magma ascent in the course of decompressional crystallization. The major volume of Bezymianny andesites is produced in the mid-crustal magma reservoir(s) as a result of decompressional fractional crystallization of parental basaltic andesites, accompanied by a mixing with silicic products from the earlier stages. Magmas which interact and blend represent cogenetic portions of different batches of melts which experienced crystallization along similar mineral cotectics. Magma stagnation and mixing complicates and slightly obscures the chemical differentiation trends but not completely wipes out the original liquid line of descent. The Bezymianny plumbing system continues to evolve at present and recently erupted andesites are the products of combined processes of (1) fractional crystallization proceeding at different echelons of the plumbing system in the course of ascend, (2) magma mixing with products of earlier stages of differentiation proceeding in the chamber or in the conduit(s), and (3) also accompanied by the inputs of new portions of less differentiated magmas. The deep-seated chemical differentiation is also complicated by the processes of (4) magma degassing and reheating at the very shallow levels of the plumbing system.

Thus, we conclude that repeated basalt injections and magma fractionation combined with internal mixing in the magma chamber are the main processes responsible for both complex petrography and geochemical trends observed in the lavas of the Bezymianny Volcano.