

Origin of volatiles emitted by Plinian basaltic eruptions of the Chikurachki volcano, Kurile arc, Russia

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Plinian eruptions of basaltic composition are relatively rare and poorly understood. Chikurachki is a 1816-m high basaltic stratovolcano in the Paramushir Island, Kurile arc, Russia, that repeatedly produced highly explosive basaltic eruptions. This work is aimed at understanding the origin of volatile components, as well as B and S isotopic compositions of a series of phenocryst-hosted melt inclusions and groundmass glasses from basaltic pyroclasts of the 1853, 1986, and prehistoric Plinian eruptions of the volcano. The volatile concentrations (47–1580 $\mu\text{g/g}$ CO₂, 0.4–4.2 wt.% H₂O, 399–633 $\mu\text{g/g}$ F, 619–3402 $\mu\text{g/g}$ S and 805–1240 $\mu\text{g/g}$ Cl) imply a sudden pressure release from ~460 to ~35 MPa, corresponding to ~1.2–16-km-depth range of magma ascent upon decompression. The $\delta^{34}\text{S}$ values of the studied inclusion and groundmass glasses range from –1.6 to +12.3‰, decrease with decreasing S, show significant positive correlations with H₂O/K₂O, Cl/K₂O and F/Zr, and negative correlations with a number of trace elements. Neither open- nor close-system magma degassing can account for the observed ~14‰ range of $\delta^{34}\text{S}$. The $\delta^{11}\text{B}$ values range from –7.0 to +2.4‰ in the interval of 13–23 $\mu\text{g/g}$ B. The relationships of $\delta^{11}\text{B}$ with B/K₂O and B/Nb are inconsistent with magma contamination at shallow crustal depths. We suggest that coherent variations of H₂O, S, Cl, F with $\delta^{34}\text{S}$ values were mainly controlled by input of volatiles from subducted slab. The behaviour of fluid-mobile vs. fluid-immobile incompatible trace elements implies that the subduction component likely represents a varying mixture of subduction-sediment-derived melt mixed with up to 60% of slab-derived fluid. The addition of ~1–8% of the inferred subduction component to the mantle wedge is required to account for the whole compositional range of the studied Chikurachki melt inclusions, and from ~0.4% to ~10% – for the composition of Kurile arc magmas with >2.5 wt.% MgO. We speculate that rapid ascent of the volatile-rich basaltic magmas from ~16-km initial depth without a prolonged residence at shallow depth is a primary reason caused Plinian character of the Chikurachki eruptions.