

Melt Inclusions Suggest Top-Down Control on Eruptive Style at Masaya Volcano

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Masaya volcano, Nicaragua, is one of the few basaltic volcanoes on Earth to have generated a wide range of eruptive styles from effusive lava lake activity to voluminous ignimbrites, surges, and Plinian fall deposits. Prior work [1] has shown an overall compositional homogeneity of the magmatic system over >30,000 years, and inferred that the volcano is underlain by a massive >10 km³ open-system basaltic magma reservoir at ~1 km depth. Due to its unique history, Masaya is an ideal case study to better constrain the primary controls on eruptive style at basaltic volcanoes. Here we analyze matrix glasses and melt inclusions hosted in olivine, plagioclase, and clinopyroxene crystals from lava lake (LL) ejecta and two Plinian deposits—the 2.1 ka Masaya Triple Layer (MTL) and the 1.7 ka Ticuantepe Lapilli (TIL)—for major, trace, and volatile (CO₂, H₂O, S, Cl, F) element concentrations to test whether pre-eruptive volatile contents may be linked to eruptive style. We find that melt inclusions from lava lake and Plinian tephra show systematic differences in pre-eruptive volatile contents, forming distinct groups with mean H₂O values of 0.6 wt.% in LL, 1.1 wt.% in MTL, and 1.9 wt.% in TIL samples. Together, these groups generate positive correlations between S, Cl and H₂O concentrations, with maximum values reaching 920 ppm, 1300 ppm and 2.3 wt.%, respectively, which are low with respect to typical maxima for Central American arc magmas [2]. Correspondingly, calculated volatile saturation pressures are also low, with means of 52 ± 33, 66 ± 35, and 96 ± 47 MPa for LL, MTL TIL samples, respectively. These observations, coupled with clear evidence for Cl exsolution during second boiling, demonstrate that, regardless of the ultimate eruption style, Masaya magmas undergo various, but extensive pre-eruptive degassing in a shallow (<4km) reservoir. Initial magma composition and anomalously high volatile contents can be excluded as primary controls on eruptive style at Masaya. Instead, our results suggest a top-down control on eruptive style whereby temporary sealing of the system may be sufficient to transition to explosive behavior. There may thus be a thin line between open-conduit conditions and Plinian eruptions at Masaya.

[1] Walker et al. (1993) *J. Volcanol. Geotherm. Res.* **56**, 379–400.

[2] Sadofsky et al. (2007) *Contrib. Mineral. Petrol.* **155**, 433–456.