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Multi-stage degassing and volatile flux at Masaya Volcano, Nicaragua

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The Masaya Caldera in Nicaragua has been known to produce a large tuff and lapili deposits during the last 20,000 years and has been nearly continuously degassing for much of recorded history. Masaya's geochemistry has revealed that this is an atypical explosive arc volcano that produces evolved basalts with no intermediate or silicic compositions. High levels of gaseous output combined with Masaya's explosive nature imply high concentrations of magmatic volatiles, yet only a handful of information on pre-eruptive volatile content exists. This work presents pre-eruptive volatiles from melt inclusions entrapped in phenocrysts in Masaya lavas, along with data for major elements, trace elements and preliminary data on fluid mobile elements in the host rocks. Intact melt inclusions in lava phenocryst phases exist, and can be examined and directly compared to quiescent period degassing results. Such correlations, where made, can shed light on the behavior of a given volcanic center during periods of activity where the volcano can be accessed, may aid in our understanding of the chemical changes prior to larger volcanic events, and may elucidate the physical nature of the magmatic plumbing system.

Melt inclusions at Masaya caldera are basaltic, with high FeO* and low MgO, and they generally mimic whole rock compositions, and the basaltic tuffs erupted during large events. Trace element signatures from melt inclusions show strong Ba enrichments and high K (PMN), while the high field strength elements Ti, Zr and Nb are more typical of those found elsewhere in Central America. These results, along with high whole rock boron concentrations and B/Zr ratios, are consistent with contributions of melts derived from mantle that has been variably metasomatized by fluids generated by the dehydration of subducted sediments. The most striking feature of Masaya melt inclusions is their low H2O (< 0.5 wt. %) and low S (<300 ppm) concentrations, coupled with anomalously high CO2 concentrations (up to $\sim$ 6000 ppm). Relationships between water, sulfur, Cl and F in combination with Masaya's high CO2 and Ba/Zr and Ba/Nb ratios suggest that Masaya has undergone a multi stage degassing process involving 1) shallow degassing where magmas rise to near surface and nearly completely degas 2) recycling of magma into a deeper reservoir by density driven drain-back, and 3) fluxing of previously degassed magma with a nearly pure CO2 vapor derived from yet deeper levels in the magmatic conduit system. This style of degassing has implications for the magmatic plumbing system. It requires an open system to depths perhaps as deep as the mid crust and likely requires that exsolved gas percolate through and equilibrate with the magma itself.