High-resolution size distributions and emission fluxes of trace elements from Masaya volcano, Nicaragua

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Active volcanoes are significant natural sources of trace elements to the atmosphere yet the processes of emission and the impacts of deposition into terrestrial and aquatic environments remain poorly understood. The varying contributions of volatile degassing and magma ejection (i.e., spattering, spraying, extrusion and fragmentation) to the emission of trace elements from Masaya volcano (Nicaragua) are investigated through measurement of high-resolution trace element size distributions using cascade impactors in 2009 and 2010. The volatile elements (e.g., As, Cd, Tl, Cu, Pb, Zn) are strongly correlated across the size distribution and exist in the plume primarily as fine sulfate (0.6 um diameter) with lesser amounts transported as coarse sulfates (3.5 um diameter) and coarse chlorides (11 um diameter). These results suggest that trace elements released from the magma as chlorides react rapidly with H_2SO_4 in the plume to form sulfates. In contrast, the non-volatile elements (e.g., alkali earth and rare earth) exist primarily as particles in the 1-10 um range and show no correlation with sulfate, chloride or the volatile elements, suggesting that they are emitted primarily by magma ejection. Trace element emission fluxes from Masaya in 2010 were estimated using filter pack measurements, with emissions of Cu, Zn, As, Tl, Rb and Cd each in excess of 10 kg d^{-1}. These emission fluxes are similar to those measured in 2000-2001 suggesting notable decadal stability in the emission of trace elements from Masaya.