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Understanding basaltic Plinian activity at Masaya caldera, Nicaragua

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Plinian eruptions are the most hazardous yet enigmatic style of volcanism at basaltic systems. The low viscosity of basaltic magma should preclude its fragmentation; however, there are several recognised examples of basaltic Plinian activity. Historical eruptions of Masaya caldera, Nicaragua; Etna, Italy (122 BC); and Tarawera, New Zealand (1886) have ejected > 1 km^3 of material. The Las Sierras-Masaya volcanic complex (Masaya caldera) has produced several basaltic Plinian eruptions, yet currently exhibits low explosive-effusive activity. This volcano has erupted chemically homogeneous magmas over at least the past 6000 years, which suggests that this significant difference in eruptive style is not attributable to a compositional change. Therefore, the cause of increased explosivity at Masaya caldera remains uncertain.

We present new measurements of major, trace and volatile elements in basaltic Plinian eruption products from the Fontana Lapilli (60 ka) and Masaya Triple Layer (2.1 ka) eruptions of the Las Sierras- Masaya volcanic complex. We use our data in rheological and thermometric models to define the pre- and syn-eruptive conditions that favour highly explosive activity. We then combine our petrological data with a numerical conduit model to constrain the pre-eruptive condition of the magma reservoir and simulate the conduit processes, to understand the magmatic conditions that promote fragmentation during magma ascent. The common physico-chemical magmatic conditions that promote basaltic Plinian activity at Masaya are high microlite crystallinity, moderate storage temperatures and a low initial H_2O concentration. Our combined approach greatly improves our general understanding of explosive basaltic activity and provides new insight into the effusive-explosive transition of the highly hazardous Las Sierras-Masaya system.