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Petrological and geochemical constraints on the recent increase in explosive activity at Santiaguito volcano, Guatemala

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The ability to forecast rapid changes in eruption style at highly active and dynamic volcanic systems is a fundamental aim for many geoscientists. Over the past century, Santiaguito's eruptive longevity of regular, small-to-moderate explosions (typical of dome-building episodes) have made it the ideal laboratory for the study of eruption dynamics. In 2015 this activity shifted to more violent, less regular explosive activity, potentially marking the onset of a renewed and recharged magmatic source. This study presents a unique, high resolution petrological and geochemical dataset using ash samples collected across this transition period, revealing detailed insights into the cause behind this rapid change in activity. Ash and bombs erupted between December 2015 and June 2016 are two-pyroxene andesites with whole-rock chemistry that is consistent with a long term trend towards more mafic material (Harris *et al*., 2003). Furthermore, although bulk chemistry is becoming more mafic, matrix glass compositions are the most evolved in all of Santiaguito's history. Despite this historical trend, the activity in early 2016 showed a rapid increase in bulk SiO_2 ($\sim$2 wt.%). The presence of xenocrystic olivine (Fo^{68-77}) mantled by orthopyroxene (En^{69}), a combination of normal and reverse zoned plagioclase phenocrysts (up to An^{91}) and the majority of amphibole phenocrysts completely broken down to pseudomorphs provide strong evidence for a system in an advanced state of disequilibrium. Magma source conditions from amphibole suggest depths of $\sim$17-24.5 km and temperatures of $\sim$960-1010˚C. Although depths are consistent with previous work (Scott *et al*., 2012), the data suggests elevated temperatures in the source region, a possible consequence of magmatic recharge. Through studying amphibole reaction rims, experiments suggest decompression alone would not be feasible to generate the textures recorded, thus providing evidence for a complex thermal and chemical history of the magma during pre-eruptive storage and ascent. Textural and micro-petrological variations have also been investigated to constrain pre-eruptive conduit conditions, focusing on microlite characteristics that facilitate assessment of crystallisation processes in the shallow conduit and magma ascent rates prior to eruption. Our data is complemented by geophysical observations recorded over the same period, providing further insights into eruption dynamics. This collaborative work not only captures unique observations of the on-going dynamic activity at Santiaguito, but aids in deciphering the complexities associated with transitions in eruptive behaviour for many active silicic volcanoes worldwide.

Harris, A.J.L., Rose, W.I., Flynn, L.P., 2003. Temporal trends in lava dome extrusion at Santiaguito 1922 – 2000. Bull. Volcanol. 65, 77–89.

Scott, J.A.J., Mather, T.A., Pyle, D.M., Rose, W.I., Chigna, G., 2012. The magmatic plumbing system beneath Santiaguito Volcano, Guatemala. Journal of Volcanology and Geothermal Research 237–238, 54–68.