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Near real-time ash time series analysis for hazard assessment: the 2015 reawakening of Cotopaxi volcano

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Near real-time analysis of ash grains ejected during eruptive activity can provide valuable information about the involvement of juvenile magma, such as the pre-eruptive depths of magma storage, and shallow ascent rates. When used in conjunction with traditional geophysical monitoring, these data help scientists refine their conceptual model of the volcanic system. After 73 years of repose, Cotopaxi volcano erupted after four months of precursory activity, including increased seismicity, gas emissions, and minor ground deformation. Ash sampling was completed throughout the new eruptive period for near real-time petrological monitoring. We collected twenty ash samples between August 14 and November 23, 2015 from a seismic monitoring site on the west flank of the volcano. Textural and compositional evolution of the ash grains was monitored thorough the eruptive episode. The presence of fresh glass in early erupted ash and the inclusion of abundant hydrothermal minerals in these samples indicates that juvenile magma interacted with the hydrothermal system, providing energy to trigger the phreatomagmatic explosions on August 14, 2015 at Cotopaxi. Subsequent eruptions were also classed as phreatomagmatic based on the lack of glassy, highly vesicular, ash grains and the presence of abundant lithic grains. After the initial explosion, crystallinity of juvenile grains increased, likely due to decreasing integrated ascent rates, however continued high measured SO2 flux suggests the system remained open to gas loss. Based on these studies in combination with seismic, gas, and deformation evidence for shallow magma residence, we concluded that magma reached the surface, but its ascent rate was slow and the system was open to continued gas outgassing and escape, which lowered the short term probability of a large explosive eruption. Combining near real-time ash monitoring with traditional geophysical monitoring techniques allowed us to gain a much clearer understanding of events than when using traditional geophysical monitoring alone.