Explosive activity at Santiaguito Dome (Guatemala): insights from Fast MoUltiparametric Setup

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Santiaguito volcano (Guatemala) is an active dome complex volcano characterized by persistent degassing to mild Vulcanian explosive activity, well known to generate a broad variety of pressure waves. Between 4th and 8th January 2012, we recorded discrete explosive events at Caliente dome by means of a multiparametric station, comprising thermal and visual high–speed cameras and two ECM microphones recording both infrasonic and sonic signals at 10 kHz sampling frequency. These impulsive events, occurring at intervals ranging from 20 to 100 minutes, vary from bursts producing 1-3 km high, white, buoyant clouds to ash-rich emissions. These gas-jetting eruptions occur at two geometrically-distinct systems of fractures: one controlled by the flow field at the upheaved lava tumuli at the summit (S1), and a second marking the rim between the issuing lavas and the confining wall rocks (S2). Each event is accompanied by tilt inflation/deflation cycles, and by seismic and acoustic signals exhibiting a broad waveform variability. Rapid vertical inflation of the dome surface can occur at the onset of explosive events. The deformation is generally confined at a prism delimited by two intersecting fractures. High speed video-sequences capturing the last 2-5 seconds prior an explosive event (500 fps, 1280x1024 pixel resolution), with horizontal field of view of 160 m (ca. 0.13 m/pixel), were extracted to quantify dome uplift by performing a particle image velocimetry (PIV) analysis, obtaining vertical velocity components of up to 0.87 m/s. Thermal video-sequences, spanning the 10-15 minutes of the degassing activity preceding a main explosive event and the explosion itself, were used to analyse the spatial-temporal evolution of thermal fluxes along S1 and S2 type fractures. For each video, the apparent maximum (T_{max}) and cumulative (T_{cum}) temperatures were measured for each opening fissure. The following observations arise: 1) T_{max} from S2 always exceeds T_{max} from S1; 2) S1 is activated before S2, although different portions of eruptive fissures can be involved in each system; 3) after S1 is activated, S2 reaches T_{max} with some delay; 4) a marked decrease in the apparent temperature is always observed immediately prior the triggering of an explosion. Our multi-parametric observations reveal a general, direct correlation between dome surface temperature, erupted ash flux volume, rate of ground uplift, and amplitude of seismo-acoustic signals. More specifically, ash-rich explosions occur at higher thermal fluxes. During such explosions dome uplifts more rapidly and, presumably as a consequence, produce higher-amplitude seismic and acoustic emissions.