Tracking of Rock fall and Pyroclastic Flow Events using Infrasound Arrays at Volcan Santiaguito, Guatemala

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Volcan Santiaguito is an active andesite/dacite dome complex in Guatemala characterized by small explosive eruptions every 0.5 - 2 hours, daily pyroclastic flows, frequent block-and-ash flows, and rock falls, including many from the neighboring Santa Maria volcano edifice. This high level of activity, along with exposure of the dome area makes Santiaguito an excellent laboratory for the study of gravity flow events using acoustic sensors. Array processing is used to identify and distinguish these events, and to track their movement through time.

We deployed arrays of two different types of infrasound microphones around Caliente, Santiaguito's current eruptive center, in January and November 2012 to record rock fall, block-and-ash flows, and pyroclastic flows. The January Array consisted of three MEMS differential pressure transducers, which possess a flat amplitude response in the band of interest (about 50 s to 50 Hz), making them ideal for waveform analysis. In november, we deployed an array consisting of eight electret condenser microphones (ECMs), characterized by a high signal-to-noise ratio, which enhances their overall detection capabilities.

We focus on the MEMS infrasound array recordings of January 2012 and corroborate analyzed signals with observations from a broadband seismometer, and one continuous time-lapse camera recording at 5 s intervals. The array was located approximately 2.5 km south and 1,000 m below the dome, with a clear view of the active slope. We locate events by conducting slowness searches for candidate sources located on the surface of the Santiaguito dome edifice. We find that the MEMS array is capable of effectively locating most moving sources of sound (i.e., block-and-ash and rock fall) for events detected by camera. The seismometer also detected rock fall events, but a single instrument is incapable of detailed source localization.

For comparison purposes, another slowness search was conducted using the November 2012 ECM array, located 1 km east, and approximately 250 m below the summit of Caliente, in view of the active south-eastern slope. Microphones were placed around the central logger with an aperture of 100 m. During he 30-hour deployment, the team observed and logged many rock falls, pyroclastic flows and small explosions (often triggering flows or rock falls), though events occurring overnight were not noted. Analysis shows movement of gravity flow events as they travel down slope with velocities from 15 to 35 m/s. This study verifies the ability of MEMS and ECM acoustic arrays to detect multiple types of events, and track their propagation through time.