Pyroclastic Flow Induced Tsunami Captured by Borehole Strainmeter during Massive Dome Collapse at Soufriere Hills Volcano, Montserrat, West Indies: Observations and Theory

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Abstract
Strainmeters at three Caribbean Andean volcano sites recorded dilatation (7-10 mm) times the seismic events leading up to 12/13 July 2003 dome collapse eruptions in Soufriere Hills Volcano, Montserrat, West Indies. Pyroclastic flows were observed entering the ocean at the Tar River Valley (TRV) site at 18:00 local time (LT) on 12 July. The eruption occurred 23:30 LT 12 July, with dome collapse consisting of 210 x 10^6 m^3 (DRE). Dilatometers at three sites recorded complex, correlated long period oscillatory wave packets with periods ~250-600 s. The strongest oscillatory signal was at Trantis, the site nearest to the TRV delta and the coastline. GEOWAVE was used to model wave initiation and propagation to test that pyroclastic flows and dome collapse into the ocean at the TRV delta stimulated tsunami. These tsunami are hypothesized to be signal the strainmeter is observing. The spectral power simulated ocean waves were compared to observed strain at Trantis. Simulated waves heights correlate with observations and demonstrate strainmeter sensitivity to geophysical processes not envisioned in the design of the installation at SHV.

CALIPSO Borehole Sites
Each CALIPSO site is equipped with a three component seismometer (Duke CIW Hz-1kHz, Pinnacle Technologies series-5000 Whitter, Astecho U-2 G2G receiver with choke ring antennas with SCION mount and radomes, and single component, very-broad-band Sacks-Evertson dilatometer.

Sensitivity Test Results
Specifically, the 3rd harmonic of the vertical seismometer at HALC, 0.18 m/s^2, was used to compare the strainmeter's sensitivity to the source event (Mattioli et al., 2004).

Conclusions
GEOWAVE, along with the methods applied by Voight and Watts provide parameter limits to simulate a pyroclastic flow entering the TRV delta in which to create tsunami similar to the 12/13 July 2003 dome collapse and pyroclastic flow events leading up to the peak collapse. Detailed simulations confirm that the unique strainmeter observations may be explained by ocean loading from pyroclastic flow generated tsunami (Mattioli et al., 2006). To quantitatively compare the signals of the strainmeter to the simulated tsunami, however, one needs to solve Green’s function, which determines the energy transfer for an elastic half-plane. Also, to further receive the actual collapse events of 12/13 July 2003, multiple pyroclastic flows causing ocean excitation should be simulated.