Characterizing the October 2010 Lava Flow of Piton de la Fournaise using Space-based data

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Over the past five decades, the use of space-based data has proven its ability in imaging and analyzing the Earth's surface. As a result, it has become a powerful tool, most importantly in volcano monitoring and hazard mitigation. Here, we present the co-eruptive and post-eruptive behavior of the lava flow of Piton de la Fournaise active during the October 2010 through integrated use of InSAR (i.e. TerraSAR-X and COSMO-SkyMed) and thermal (i.e. MODIS) remote sensing data. Horizontal and vertical displacement maps derived from syn-eruption TerraSAR-X data shows that the October 2010 eruption was related to the injection of a dyke. It extended to SSE direction from the summit breaking the surface at 2000 m a.s.l.. Analysis of the post-eruption data involved phase unwrapping, detrending, phase inversion and application of corrections to take into account bad unwrapping of a large database of COSMO-SkyMed interferograms. This revealed that the lava flow subsided at a maximum rate of 13.5 cm/yr and deformed, mostly eastward, at a maximum rate of 4 cm/yr. The slope of the volcano is assumed to be the cause of the East-West displacement of the lava flow (i.e., deformation is gravity-driven), whereas the subsidence can be attributed to: 1) poro-visco-elastic relaxation of the substratum and the lava flow due to the gravity load and compaction, 2) thermal contraction of the lava flow during cooling, and 3) other non-linear processes occuring within, and beyond, the lava flow. In addition to the deformation, we produced a thickness map which illustrated the extent and boundary of the emplaced lava flow. We derived a DRE volume of 3.06 ± 0.19 Mm^3 from the lava thickness map after considering a vesicularity of 20 percent. The InSAR characterization results were cross-validated with results obtained from converting MODIS spectral radiance data to lava discharge rates during the eruption. This integration of the MODIS-derived discharge rates through time also gave a volume estimate of 3.0 Mm^3. The discharge rate time series also revealed a waxing-waning behavior, which also implies eruption from a pressurized (dyke) source.