Geophysical Research Abstracts
Vol. 20, EGU2018-18957, 2018
EGU General Assembly 2018

Small-scale outgassing dynamics at the Halema'uma'u' lava lake.

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Outgassing at lava lakes occurs through a variety of phenomena over at a range of spatial and temporal scales. Observations using high-frequency (50-500 Hz) thermal and visible imaging of the currently active "Overlook" lava lake at Halema'uma'u crater revealed that besides major persistent outgassing occurring at the surface during convection-driven lava spattering, magmatic volatiles physically escape from the low-viscosity magma also through minor outgassing phenomena. Two main recurrent behaviours were observed from continuous imaging of the lava lake during discrete, hours-long campaigns in Dec 2013 and Dec 2015. The first consists mainly of recurrent meters-wide upwelling of the lava lake surface caused by 'trapped bubbles'. These gas pockets can be either stationary or travel sub-plate independently of the general lake circulation, eventually followed by discrete bubble bursting through the free surface ejecting hot gas and ductile magma fragments. The second consist of prolonged hot gas discharge from decimetres-wide 'spot vents', i.e. pierced portions of the plate where outgassing occurs without visible spattering. These features appear to move coupled with the cooling plates and thus follow the general circulation pattern. Given the small spatial and temporal scales of these phenomena, these two outgassing styles are mostly 'invisible' to both surveillance cameras, typically capturing data at lower resolutions and frame rates, and gas geochemistry measurements, that sample cumulative emissions from the overall lake outgassing. Preliminary investigation included event frequency, duration, time and spatial distribution, and variation in the fluxes of gas/material ejected. Our observations are consistent with the presence of an accumulation of gas, within foam, trapped just below the thin crust of the plate system. When this relatively stable crust-foam system is locally perturbed by, .e.g. crust stretching/ thinning due to plate drift, or coalescence of small bubbles into larger ones, over-pressure driven instabilities cause the shallow gas to expand and burst.