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Intra-eruptive gas emissions and shallow magma storage after the 2007 summit caldera collapse of Piton de la Fournaise, Reunion island.

A. Di Muro (1), A. Aiuppa (3), M. Burton (3), N. Metrich (1), P. Allard (1), T. Fougereux (1), G. Giudice (3), and R. Guida (3)

(1) Institut de Physique du Globe de Paris (IPGP), UMR7154, Paris, France, (3) Istituto Nazionale di Geofisica e Vulcanologia (INGV), Italy

In spite of its frequent eruptive and intrusive activity (1 event/9 months, on average), Piton de la Fournaise volcano is characterized by weak gas emissions during intra-eruptive periods. This behaviour clearly contrasts with that of other persistently active mafic volcanoes such as Etna, Popocatepetl, Hawaii, Stromboli or Yasur. At Piton de la Fournaise, visible surface gas emissions between eruptions occur as low-temperature (<100 °C) fumaroles on the inner cliffs of the summit Dolomieu crater and steam release from peri-crateric fractures. Occasional bursts of vapour from the summit crater occur during intense rain episodes because of the presence of recent and still hot lava flows and dykes.

We here report on results for i) the first periodic monitoring of the summit crater fumaroles (H₂O, CO₂, SO₂, H₂S) during October 2010 to January 2012, using a MultiGAS sensor device, and ii) the dissolved volatile content of melt inclusions and crystal-melt equilibria in post-2007 eruptive products. The post-2007 PdF activity consisted in small volume (0.1-2.9 Mm³) and often short-lived, summit or proximal eruptions and several shallow intrusions. The activity cycle in the period October 2010-January 2012 consisted in two proximal eruptions (October and December 2010) and one shallow intrusion (February 2011, about 2 km below volcano summit). The intrusion was followed by a general trend of decreasing seismic activity (both in number and energy of events) and increasing host-medium seismic velocity, consistent with an observed contraction and deflation of the summit cone. We show here that PdF crater fumaroles are steam-dominated (H₂O/CO₂: 170-30) and emit H₂S as the only sulphur species (CO₂/H₂S: 20-180; no SO₂ detected, at least since April 2011). We find that the decrease in seismic activity and edifice contraction since February 2011 was paralleled by markedly decreasing H₂O/CO₂ ratio and increasing CO₂/H₂S ratio, which could reflect declining rates of H₂O and H₂S (residual) degassing from the cooling shallow magma intrusions.

Melt inclusion studies and mineral equilibria analysis indicate that the basalts recently emitted by Piton de la Fournaise had a relatively low MgO content (MgO: 7.1±0.6 wt%), quite uniform moderate contents of water (H₂O max 1 wt%) and sulphur (S<1600 ppm), and were poor in carbon (CO₂<300 ppm). These observations support the hypothesis that the recent volcanic activity was due to magma transfer and storage within a relatively small (<50 MPa) pressure/depth range, corresponding to the subaerial part of the volcanic pile. In such conditions H₂O and sulphur are likely to be the most sensitive volatiles for tracking the evolution of PDF volcanic activity.