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First measurements of magmatic gas composition and fluxes during an eruption (October 2010) of Piton de la Fournaise hot spot volcano, La Reunion island

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Piton de la Fournaise (PdF), in the western Indian Ocean, is a very active hot spot basaltic volcano, with 1-2 fissure eruptions per year on average. Its magmas have been widely studied and its eruptions are well anticipated by the local seismic-geodetic monitoring network. However, no datum was yet available for its magmatic gas emissions (restricted to only eruptive phases and hardly accessible). Here we report on the first measurements of the chemical composition and mass flux of magmatic gases emitted during a PdF eruption in October 2010. Hot gases arising from different eruptive vents were remotely measured with OP-FTIR spectroscopy, using molten lava fragments as IR radiation source, which allowed simultaneous detection of H2O, CO2, SO2, HCl, HF and CO. In situ MultiGas direct analysis of H2O, CO2 and SO2 was also performed in volcanic plumes downwind of the vents. The results reveal a surprisingly H2O-rich (98-97 mol %) and CO2-poor (1.0-1.8%) magmatic gas, whose H2O/CO2 ratio however decreased while C/S (1.2-1.9), S/Cl (13-35) and Cl/F (9.7-12) ratios increased during the course of the eruption. In the same time, SO2 fluxes, measured during walking and helicopter-borne DOAS traverses under the volcanic plume, rapidly dropped from 5 to 1.8 ktons as the eruption intensity and lava effusion rate were lowering. From DOAS and OP-FTIR data we derive the emission rate of each gas species and the evolution of total gas flux during that event. Combining these results with available literature data for dissolved volatiles in PdF magmas allows us to draw some preliminary conclusions: (i) Contemporaneous SO2, HCl and HF fluxes and lava effusion rates are compatible with a pure syn-eruptive magma degassing process; (b) In contrast, the inferred emission rates for H2O and CO2 suggest some separate CO2 bubble transfer and a water contribution from the hydrothermal system to H2O degassing (steam entrainment during dyke propagation; (c) The changes in gas composition over time is consistent with lower external fluid addition and with an increasing proportion of truly magmatic volatiles in gas emissions, even though the eruption intensity was lowering; and (d) It remains that PdF hot spot mantle source is confirmed to be water-dominated, instead of CO2-rich. Further gas measurements during future PdF eruptions and their cross-correlation with geophysical signals should provide increased insight into the conditions of magma ascent and degassing from the storage reservoir.