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Two degassing paths in magmas from Reunion hotspot : constraints from melt and fluid inclusions

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Piton de la Fournaise (Reunion Island) is one of the most active volcanoes worldwide, yet the position, depth and shape of its magma reservoirs are not well constrained. By combining melt and fluid inclusion data from the February 2005 eruption with published data, we provide new insights on the plumbing system and the dynamics of magma ascent.

Olivine xenocrysts (Fo% = 84-85) embedded in the Feb. 2005 lavas contain primary melt inclusions (glass±oxides±bubble) and planes of secondary fluid inclusions (CO_2±glass±oxides). EPMA analyses of major elements in primary inclusions indicate a primitive source at 1200-1230˚C, while secondary inclusions suggest a more differentiated reservoir. FTIR measurements show that primary melt inclusions contain 0.1 to 1 wt% H_2O and 0 to 0.06 wt% CO_2. These volatile concentrations, together with Micro-Raman densimetry on secondary CO_2 inclusions, indicate that the fluids were trapped all along the magma ascent from 4-5 km to the subsurface. Combined with published melt inclusion data, the Feb. 2005 inclusions define two fields of volatile content : 1) A low CO_2 field for shallow and differentiated eruptions, consistent with an open system degassing. 2) a high CO_2 field for deep and primitive eruptions, consistent with a closed system degassing. The fact that both degassing paths occur in the Feb 2005 lavas implies that this magma picked up xenocrists from at least two independent storage reservoirs during its ascent.

In addition, the "Total Volatile lines" method (Papale 2005, JGR 110, doi: 10.1029/2004JB003033) applied to primary melt inclusions gives a minimum estimate of 1.1±0.1 wt% H_2O and 5±1 wt% CO_2 for the total volatile content (dissolved+exsolved) in shallow magma reservoirs, consistent over all the database of differentiated melt inclusions. For deeper magmas, however, the “Total Volatile lines” method is not applicable because the proportion of CO_2 relative to H_2O increases during ascent instead of decreasing. This relative CO_2 enrichment may be due to the rise of exsolved bubbles that accumulate in the conduit. Overall, the data confirm the existence of different reservoirs at 4-5 km and beneath the Piton de la Fournaise, independently degassing yet transiently interconnected during deep magma ascents.