Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.17599

Constraining the H_2O content of primary basaltic melts of Montagne Pelée volcano with ultramafic cumulates

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Montagne Pelée (Martinique Island, Lesser Antilles) is an arc stratovolcano that is extremely hazardous due to his predominantly explosive character. The famous 1902 eruption that claimed 28,000 lives is the deadliest eruption of the 20th century. This volcano has recently been raised to the yellow alert level due to increased volcanic seismicity.

Yet, the volatile composition of Montagne Pelée basaltic melts are unknown due to the absence of primitive melt inclusions in early crystallizing phases (olivine, clinopyroxene).

In this study, ultramafic plutonic rocks from Montagne Pelée volcano are reported for the first time. These cumulates are low-Al_2O_3, high-MgO rocks of diverse modal compositions : wehrlite, olivine-hornblendite, and high-MgO gabbro. They have the most primitive (Cr-bearing) spinels ever found for Montagne Pelée volcano and Martinique Island. Their composition shows that they record the change in crystallization assemblage from ol+cpx to plag+amph±ol±cpx at a peak melt Al_2O_3 content of 20.5 wt%. Barometric calculations suggest crystallization pressures in the range 2.4-5.2 kbars.

The modelling of fractional crystallization processes from a likely primary melt (the Ilet à Ramiers high-MgO basalt) to the most evolved melt compositions shows that the peak Al_2O_3 melt content is reached after 40% crystallization of mostly ol+cpx. Using the petrological hydrometer of Parman et al. (2011) [1], the water content of differentiated basaltic melts at the onset of plagioclase crystallization is 5.8 wt%. If the high-MgO Ilet à Ramiers basalt is assumed to be a good working hypothesis composition for Montagne Pelée primary melts, then their water content is 2.4 wt%. This shows that Montagne Pelée volcano primary basaltic melts produced by the mantle are rich in water even before undergoing any crystallization episode.

Reference

[1] Parman et al. (2011), *J. Petrol.* 52, 257-278.