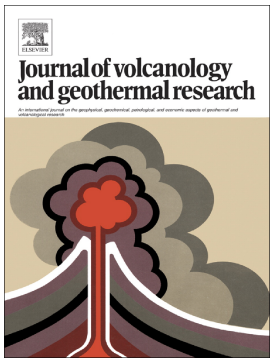

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Storage conditions of the mafic and silicic magmas at Cotopaxi, Ecuador

Caroline MARTEL[a], Joan ANDÚJAR[a], Patricia MOTHES[b], Bruno SCAILLET[a], Michel PICHAVANT[a], Indira MOLINA[b]

[a]Institut des Sciences de la Terre d'Orléans (ISTO), Université d'Orléans-CNRS-BRGM, Orléans, France

[b]Instituto Geofísico, Escuela Politécnica Nacional (IGEPN), Quito, Ecuador

ABSTRACT

The 2015 reactivation of the Cotopaxi volcano urges us to understand the complex eruptive dynamics of Cotopaxi for better management of a potential major crisis in the near future. Cotopaxi has commonly transitioned from andesitic eruptions of strombolian style (lava flows and scoria ballistics) or nuées ardentes (pyroclastic flows and ash falls) to highly explosive rhyolitic ignimbrites (pumiceous pyroclastic flows), which entail drastically different risks. To better interpret geophysical and geochemical signals, Cotopaxi magma storage conditions were determined via existing phase-equilibrium experiments that used starting materials chemically close to the Cotopaxi andesites and rhyolites. The results suggest that Cotopaxi´s most mafic andesites (last erupted products) can be stored over a large range of depth from ~7 km to $\geq$ 16 km below the summit (pressure from ~200 to $\geq$ 400 MPa), 1000 °C, NNO +2, and contain 4.5-6.0$_{\pm 0.7}$ wt% H_2O dissolved in the melt in equilibrium with ~30-40% phenocrysts of plagioclase, two pyroxenes, and Fe-Ti oxides. These mafic andesites sometimes evolve towards more silicic andesites by cooling to 950 °C. Rhyolitic magmas are stored at 200-300 MPa (i.e. ~7-11 km below the summit), 750 °C, NNO +2, and contain ~6-8 wt% H_2O dissolved in a nearly aphyric melt (less than 5% phenocrysts of plagioclase, biotite, and Fe-Ti oxides). Although the andesites produce the rhyolitic magmas by fractional crystallization, the Cotopaxi eruptive history suggests reactivation of either reservoirs at distinct times, likely reflecting flux or time fluctuations during deep magma recharge.

Keywords: Cotopaxi; andesite; rhyolite; experimental petrology; eruptive dynamics