CO_2-flush, volatile with subduction flavor, and plumbing system architecture at a continental rift segment

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The plumbing system architecture governs the evolution of magma composition in any igneous system, and has therefore implications on eruptive dynamics and on societal issues related to risks, or mineral resources. In continental rift settings its organization is dependent on the degree of maturity of the rift, and may vary along the segment (from center to tip). Volatile elements are key tools to decipher on the mantle source characteristics of magmas, on plumbing system architecture, and govern eruptive dynamics and explosivity. Melt inclusions (MI) almost preserve the deep volatile signature and record the processes likely occurring in deep magma or mush reservoirs (differentiation, degassing...).

Here we quantify the volatile content (H_2O, CO_2, Cl, F, S) along with major and trace elements of MI from 6 basaltic eruptions localized along the Chaîne des Puys rift segment in central France (<100ka). Segment is composed of ca 100 edifices that range from basaltic to rhyolitic. Silica-rich magmas are volatile-rich and have been interpreted as being emitted from a single mid-crust reservoir (6-15km^3).

Parental magmas contain ~1000ppm Cl, ~600ppm F, and ~3500 ppm S typical of supra-subduction environments. This highlights that the mantle source records older (Variscan) subduction related metasomatism. Redox conditions estimated from $D_V^{Olivine-melt}$, and from S speciation (from EPMA) point to a value of Δ_{QFM}=0.6. CO_2 contents are up to ~7000ppm consistent with a storage reservoir and MI entrapment depth close to the regional Moho (~25km). CO_2-H_2O co-variations highlight two different evolutions for the six studied edifices: the Northern one (tip of the segment) is water poor (~0.4 wt%), when initial water contents are higher (~2.5 wt%) elsewhere in the rift segment. Given the similarity in major and trace element compositions of the MI along the segment, source or crustal contamination variations are unlikely to account for this H_2O variation. Water depletion is associated with slightly higher K_2O contents, and slightly higher entrapment temperature of MI. This together with the former identification of free CO_2 in mantle xenoliths from the Northern edifice highlight that a CO_2-flush process proceeded at the tip of the reservoir resulting in H_2O loss at depth.