Halogen concentrations and chlorine isotope compositions along the lesser Antilles arc recorded in thermal springs

M. BONIFACIE[1,2]*, G. BARDOUX[2], V. ROBERT [1,2], C. DESSERT[1,2], S. MOUNE[3], P. AGRINIER[1] AND E.P. JOSEPH[4]

[1] Observatoire Volcanologique et Sismologique de Guadeloupe, IPGP (*correspondence: bonifaci@ipgp.fr)
[2] Institut de Physique du Globe de Paris, France
[3] Laboratoire Magma et Volcans, Clermont Ferrand, France
[4] Sesismic Research Center, University of the West Indies

The halogen elements show a unique combination of geochemical features that can be used to inimitably trace exchanges between the surface and the interior of the Earth and the history of magmas (from their origin through their differentiation, degassing and interactions with fluids) [1-3]. Notably, when compared to other volatiles, chlorine and bromine are: 1/ the most shallowly degassed from magmas, mainly as HCl and HBr; 2/ highly hydrophilic, and can thus be efficiently trapped as Cl^- and Br^- in thermal waters overlying magma bodies; 3/ considered as chemically inert.

In order to provide constraints on the sources and fate of Cl and Br associated with arc volcanism, this study reports Cl-Br concentrations and $\delta^{37}Cl$ signatures of thermal springs from several locations along the Lesser Antilles arc: la Soufrière de Guadeloupe (French West Indies); Boiling Lake, Valley of Desolation and other locations (Dominica); and Liamuiga (St-Kitts). The studied samples show wide ranges of temperature (22-92°C), pH (3-8), Cl content (10-2000 ppm), Cl/Br ratio (100-1000) and $\delta^{37}Cl$ value (-1‰ to 0‰). Magmatic Cl displays negative $\delta^{37}Cl$ values (close to -0.7‰) all along the arc, in agreement with a slab-derived origin. The consistency with the melt inclusion data from St Vincent, at the South of the arc ($\delta^{37}Cl$ averaging -0.64‰ [4]) further confirms our starting hypotheses that Cl isotopes do not fractionate (ie. no loss of magmatic Cl) over their high-temperature path from magma to thermal springs.

For further constraining local magmatic and hydrothermal processes at la Soufrière de Guadeloupe, we will also report on a long-term record of Cl, Br, F and I concentrations and $\delta^{37}Cl$ values of the Galion thermal spring over 40 yrs (showing discrete peaks of Cl contents that are anti-correlated with $\delta^{37}Cl$ values) and the summit acid pond Tarissan over 13 yrs (pH from -0.8 to +0.8 and [Cl] = 1-15 wt.%).

[1] Pyle & Mather (2009), *Chem. Geol.* **263**, 110–121. [2] Bonifacie (2017), *Encyclopedia of Geochemistry*. [3] Li et al. (2015) *EPSL* **413**, 101–110. [4] Manzini et al. (2017) *Chem. Geol.* **449**, 112–122.