Preliminary results of biomonitoring survey at Virunga Volcanic Province (D.R. Congo), Eastern Africa.

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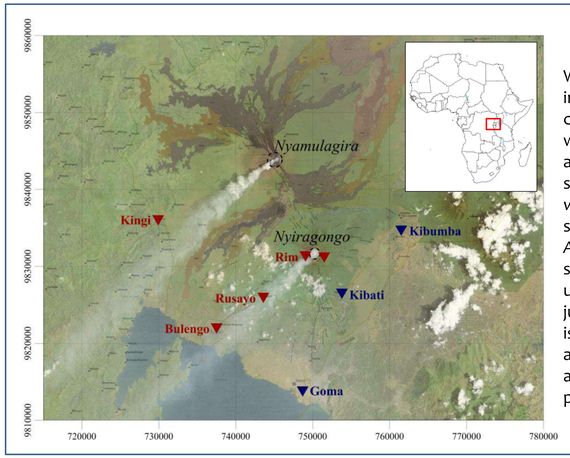
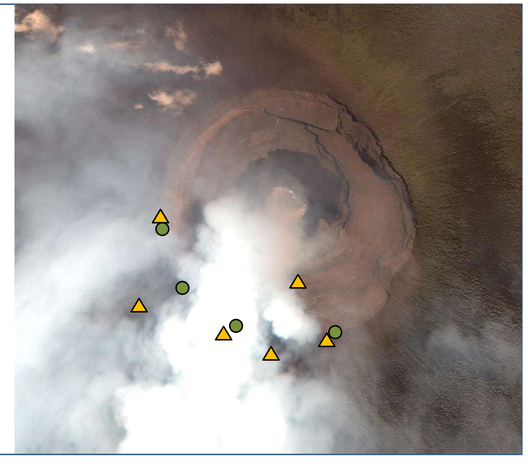
Introduction

Volcanic emissions represent one of the most important natural sources of major and trace elements (gases and particulates) to the atmosphere (e.g. S, F, As, Cd, Cu, Hg, Pb, Sb, Tl and Zn), sequentially influencing the other geochemical spheres (hydrosphere, lithosphere and biosphere) through atmospheric deposition. Nyiragongo and Nyamulagira volcanoes, in the Virunga Volcanic Province (Democratic Republic of Congo), are among the ten major emitters of volatiles to the atmosphere. Biomonitoring techniques have been widely used in environmental studies to monitor anthropogenic pollutants. Recently such techniques have been also applied to ascertain the impact of contaminants naturally released by volcanic activity (Calabrese et al., 2015; Arndt et al., 2017). In the present study a biomonitoring survey has been performed in different sites around Nyiragongo and Nyamulagira active volcanoes (D.R. Congo). Here, we report the first preliminary results of a new and original study on atmospheric depositions collected in 2011 and 2014, aiming to investigate the impact of the volcanogenic deposition in the surrounding of these two active volcanoes.



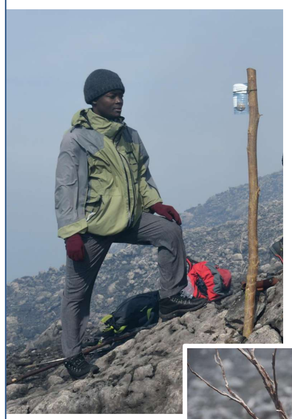
Materials and Methods

We applied both active and passive biomonitoring techniques in order to investigate the potential release of some harmful chemical elements by Nyiragongo and Nyamulagira: the former was performed by exposing moss-bags (*Sphagnum sp.*) as active accumulators of volcanic gases and particles. At the same time, additional samples were collected from *Amaranthus viridis and Senecio sp.* leaves, as well as liquid samples from squeezed banana tree (*Musa paradisiaca* and *Musa nana*). Both *Amaranthus viridis and* banana are plants widespread in the study area and locally edible. While *Amaranthus viridis* is solely used as vegetable, banana is a starchy and additionally used for juice and wine production. All leave samples were gently isolated, dried and powdered avoiding metal contamination for acid microwave extraction (HNO_3 + H_2O_2). Solutions were analyzed for major and trace elements by inductively coupled plasma spectrometry (ICP-MS and ICP-OES) for 49 elements.

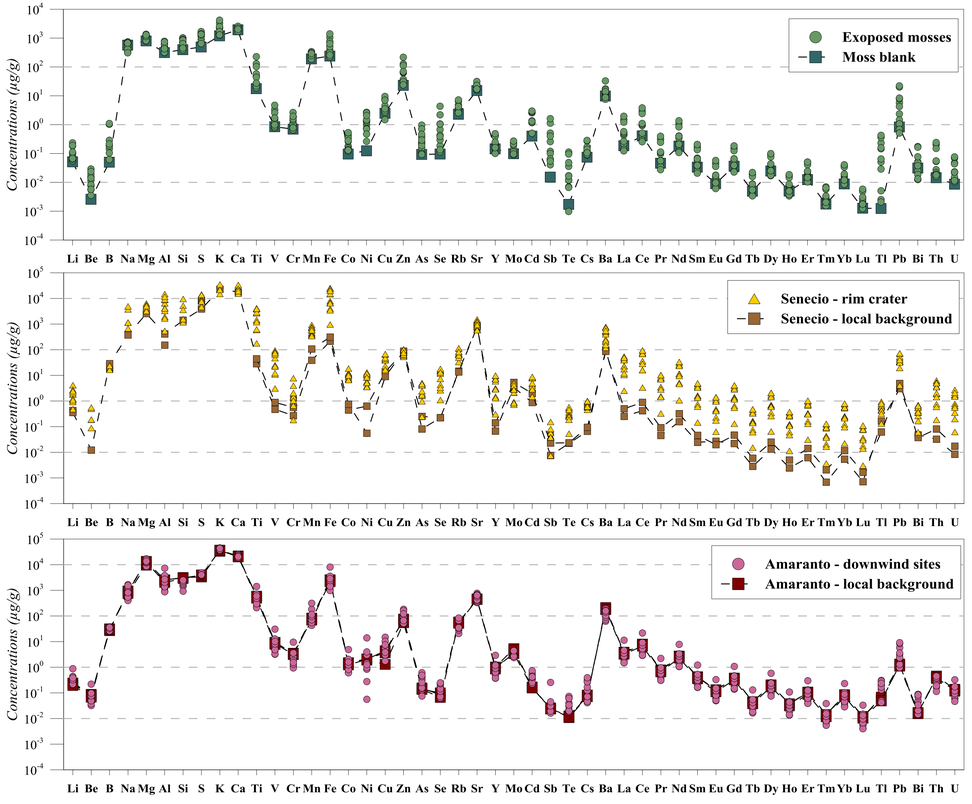


Active biomonitoring

At Nyiragongo, 14 moss bags were exposed at the crater rim and at two down-wind distal sites (the villages of Kingi and Rusayo). During the sampling periods (December 10th – 14th 2011 and October 26th–November 13th 2014), weather conditions were typically tropical with high temperatures and humidity during the days and heavy rainfall of about 50–100 mm within about 3 h each afternoon. Prevailing winds were north-northeastern. Preliminary results show a clear fingerprint of volcanic emissions both in the exposed moss bags and in the collected plants.



Several elements (Al, As, Ba, Bi, Fe, Mo, Sb, Se, Sr, Te, Tl, Pb) are strongly enriched in the mosses exposed to the volcanic emissions with the highest enrichment measured close to the summit crater. Furthermore, evidences of metal bioaccumulation are also found in the downwind sites (e.g. Kingi and Rusayo villages), at several km from the volcanic source.



Passive biomonitoring

Leaves of the studied plants also reflect the geographical dispersion of the volcanic plume, especially for highly volatile elements in high temperature volcanic environments such as Tl, Te, Bi, Se, Cu, As, Cd, S. Also alkali metals showed a significant increase in their concentrations, probably because of their affinity for the halide species, which are often carried by particles (ashes, pele's hair and tears, lithics) produced by the spattering and fracturing at the lava lake surface. The liquid water from banana samples has elevated concentrations of nutrients (Na, K, Mg, Ca, Cl) and trace metals (B, Ba, Cs, Rb, Zn, Tl). The preliminary results clearly highlighted a potential hazard for the population that lives close to Nyiragongo and Nyamulagira volcanoes.

The water liquid from squeezed banana tree is further used for cooking and drinking in some localities around Nyiragongo and Nyamulagira during rainwater scarcity in the dry season. Any presence of volcanogenic harmful elements in these plants would lead to potential health risk for the population living around Nyiragongo and Nyamulagira volcanoes. These plants can thus be used in the assessment of the environmental impacts and the human health hazard associated with Nyiragongo and Nyamulagira volcanic emissions