Geophysical Research Abstracts
Vol. 20, EGU2018-7221-1, 2018
EGU General Assembly 2018

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

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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 (D.R. Congo), active volcanoes in the western branch of the East African Rift. We applied both active and passive biomonitoring techniques in order to investigate the 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 starchy and additionally used for juice and wine production. The liquid from squeezed banana tree is further used for cooking and drinking in some localities around Nyiragongo and Nyamulagira during the dry season. Any presence of volcanogenic harmful elements in these plants would lead to potential health risk for the population living around these volcanoes. These plants can thus be used to assess the environmental impact and the human health hazard associated with Nyiragongo and Nyamulagira volcanic emissions. 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. 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. However, evidences of metal bioaccumulation are also found in downwind sites (e.g. Kingi village, at several km from the volcanic source). 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 high 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 live close to the Nyiragongo and Nyamulagira volcanoes.

Calabrese et al., 2015, Chemosphere, 119, 1447-1455
Arndt et al., 2017, JVGR, 343, 220-232