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Passive degassing at Nyiragongo (D.R. Congo) and Etna (Italy) volcanoes: the chemical characterization of the emissions and assessment of their uptake of trace elements emissions on the local environment

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Volcanoes are well known as an impressive large natural source of trace elements into the troposphere. Among others, Etna (Italy) and Nyiragongo (D.R. Congo), two noteworthy emitters on Earth, are two stratovolcanoes located in different geological settings, both characterized by persistent passive degassing from their summit craters.

Here, we present some results on trace element composition in volcanic plume emissions, atmospheric bulk deposition (rainwater) and their uptake of the surrounding vegetation, with the aim to compare and identify differences and similarities between this these two volcanoes. Volcanic emissions were sampled by using active filter-pack for acid gases (sulfur and halogens) and specific teflon filters for particulates (major and trace elements). The impact of the volcanogenic deposition in the surrounding of the crater rims was investigated by using different sampling techniques: bulk rain collectors gauges were used to collect atmospheric bulk deposition, and biomonitoring technique was carried out to collect gases and particulates by using endemic plant species. Concentrations of major and trace elements of volcanic plume emissions (gases and particulates) were obtained by elution and microwave digestion of the collected filters: sulfur and halogens were determined by ion chromatography and ICP-MS, and untreated filters for particulate were acid digested and analysed by ICP-OES and ICP-MS. Rain water and plant samples were also analysed for major and trace elements by using ICP-OES and ICP-MS. In total 55 elements were determined.

The estimates of the trace element fluxes confirm that Etna and Nyiragongo are large sources of metals to the atmosphere, especially considering their persistent state of passive degassing. In general, chemical composition of the volcanic aerosol particles of both volcanoes is characterized by two main components: one is related to the silicic component produced by magma bursting and fragmentation, enriching the plume in Si, Al, Fe, Ti, Mg, Ca, Na, K and other trace elements like Ni, Cr, Co, Th and U; another one components, is dominated by volatile trace elements (As, Bi, Cd, Cu, Hg, Se, Te, Tl) related to the gas volatile phase (H_2O, CO_2, SO_2, HCl, HF) and transported to the atmosphere mainly as hydro-soluble salts and/or in gaseous form in some cases.

The large amount of emitted trace elements have a strong impact on the close surrounding of both volcanoes. This is clearly reflected by in the chemical composition of rain water collected at the summit areas both for Etna and Nyiragongo. In fact, rain water samples have low pH values (<2) and high concentrations of dissolved toxic metals. Moreover, the biomonitoring results highlight that bioaccumulation of trace elements is extremely high in the proximity of the crater rim and decreases with the distance from the active craters. In particular, we found a good correlation between volatile elements (Tl, As, Bi, Cd, Se, Cu) concentrations in the leaves of Senecio species collected in on both volcanoes, showing a clear influence of volcanic deposition.