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Dissolved major and trace elements in meteoric depositions on the flanks of Mt. Etna (Italy): the impact of volcanic activity on the environment

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In the framework of the "Save the Etna World" research project, which investigates the impact of the volcanic activity on the surrounding environment, three bulk collectors were deployed on the flank of the Mt. Etna volcano to collect the meteoric depositions. The sampling sites were at distances between 5.5 and 13 km from the summit vents of the volcano on its eastern flank, that is the most exposed to the volcanic plume due to the high-altitude prevailing winds direction. The sites were selected in order to have a gradient of exposition with respect to the volcanic emissions, the most exposed being CIT, the intermediate ILI and the least NIC. Samples were collected monthly from July 2017 to July 2018 and analysed for major ions and for a large suite of trace elements.
The influence of volcanic emissions is evidenced by the low pH of the collected depositions in the most exposed site, showing values mostly below 3.5 and never exceeding 5.72. The lowest values are related to high fluoride, chloride and sulfate concentrations in the collected water, deriving from the acid gases (HF, HCl and SO_2) of the volcanic plume. The other two sites show pH values in range from 3.95 to 7.21. While the lowest values indicate a lower but significant volcanic influence, the highest values can be related to the dissolution of geogenic (mainly carbonate) particulate of local or regional (Saharan) origin. The latter process is evidenced by high concentrations of Ca and HCO_3 in the samples with the highest pHs.
Trace elements show almost all higher concentrations in the most exposed site. Highly volatile elements like Pb, Te and Tl, which are known to have strong enrichment factors in volcanic plumes with respect to the average upper crust composition, are found at CIT at concentrations always at least one order of magnitude higher than at NIC. Also lithophile elements like Si, Al, Ti and Fe are sometimes strongly enriched at CIT deriving from the interaction of the acid gases of the plume with the occasionally emitted volcanic ash.
These new results confirm the importance of meteoric deposition as main carrier of volcanogenic elements to earth's surface. "Etna World" is a fascinating natural laboratory, and the study of atmospheric depositions in this peculiar environment allows to understand better the general processes that influence the cycles of trace metals. Furthermore, the quantitative estimation of both emission and deposition of volcanogenic elements is a key factor for complementary studies on the geochemical mobility of trace elements and their distribution between atmosphere, soils, vegetation, and lastly, animals and humans in active volcanic areas.