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Atmospheric impact of volcanic volatiles: trace elements in snow and bulk deposition samples at Mount Etna (Italy)

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Volcanoes represent an important natural source of several trace elements to the atmosphere. For some species (e.g., As, Cd, Pb and Se) they may be the main natural source and thereby strongly influencing geochemical cycles from the local to the global scale. Mount Etna is one of the most actively degassing volcanoes in the world, and it is considered to be, on the long-term average, the major atmospheric point source of many environmental harmful compounds. Their emission occurs either through continuous passive degassing from open-conduit activity or through sporadic paroxysmal eruptive activity, in the form of gases, aerosols or particulate. To estimate the environmental impact of magma-derived trace metals and their depositions processes, rainwater and snow samples were collected at Mount Etna area. Five bulk collectors have been deployed at various altitudes on the upper flanks around the summit craters of the volcano; samples were collected every two week for a period of one year and analyzed for the main chemical-physical parameters (electric conductivity and pH) and for major and trace elements concentrations. Chemical analysis of rainwater clearly shows that the volcanic contribution is always prevailing in the sampling site closest to the summit crater (about 1.5 km). In the distal sites (5.5-10 km from the summit) and downwind of the summit craters, the volcanic contribution is also detectable but often overwhelmed by anthropogenic or other natural (seawater spray, geogenic dust) contributions. Volcanic contribution may derive from both dry and wet deposition of gases and aerosols from the volcanic plume, but sometimes also from leaching of freshly

emitted volcanic ashes. In fact, in our background site (7.5 km in the upwind direction) volcanic contribution has been detected only following an ash deposition event. About 30 samples of fresh snow were collected in the upper part of the volcano, during the winters 2006 and 2007 to estimate deposition processes at high altitude during cold periods. Some of the samples were collected immediately after a major explosive event from the summit craters to understand the interaction between snow and fresh erupted ash. Sulphur, Chlorine and Fluorine, are the major elements that prevailingly characterize the volcanic contribution in atmospheric precipitation on Mount Etna, but high concentrations of many trace elements are also detected in the studied samples. In particular, bulk deposition samples display high concentration of Al, Fe, Ti, Cu, As, Rb, Pb, Tl, Cd, Cr, U and Ag, in the site most exposed to the volcanic emissions: median concentration values are about two orders of magnitude higher than those measured in our background site. Also in the snow samples the volcanic signature is clearly detectable and decreases with distance from the summit craters. Some of the analysed elements display very high enrichment values with respect to the average crust and, in the closest site to the summit craters, also deposition values higher than those measured in polluted urban or industrial sites.