Diffusive emission of organic trace gases from the flank and crater of a quiescent active volcano (Vulcano, Aeolian Islands, Italy)

Florian M. Schwandner (1)

Terry M. Seward (1)

Andrew P. Gize (2)

P. Anthony Hall (3)

Volker J. Dietrich (1)

(1) Institute of Mineralogy and Petrography (IMP), Swiss Federal Institut of Technology (ETH) Zürich, 8092 Zürich, Switzerland

(2) Department of Geological Sciences, University of Manchester, Manchester M13 9PL, UK

(3) Hall Analytical Ltd., Milbrook Business Centre, Floats Road. Manchester M23 9YJ, UK

Abstract

Volcanoes discharge a range of major gas species (i.e. H_2O, CO_2, SO_2, CO) not only during eruptions but also in quiescent phases, through fumarolic as well as diffusive degassing in their craters and on their flanks. The emission of trace gases such as natural halocarbon compounds from volcanoes is in the same regard not expected to be restricted to discrete fumarolic gas discharges alone. To test this hypothesis, we have sampled soil gas emissions of organic compounds and determined CO_2 fluxes along a profile spanning from the vegetated base of the active La Fossa cone (Vulcano Island, Italy) over the unvegetated volcanic flank, the crater rim and base, into fumarolic areas.

The results indicate that a) the majority of volatile organic compounds in the soil gas show significant increases in concentration towards the crater and fumaroles, b) emissions of the halocarbon CFC-11 (CCl_3F) correlate well with soil CO_2 fluxes measured on site (R^2=0.91 ±0.02) and both increase towards the crater and fumaroles, and c) diffusive emissions therefore contribute significantly to the volcanic halocarbon source strength. Other ozone depleting substances were found in concentrations significantly above those found in field and system blanks, including CH_3Br, CH_3Cl, CH_3I, C_2H_5Br, and chlorinated benzenes. Abundances range from upper pptv to ppmv (e.g. CFC-11: max. 1200 pptv diffusive, 3700 pptv fumarolic/dry gas, dry air: 268 pptv). On the basis of these results, the natural volcanic source strength of halocarbon emissions to the atmosphere requires re-evaluation and correction to higher values.