Monitoring volcanic fluxes using eddy covariance at Solfatara volcano, Naples, Italy

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Eddy covariance (EC) is a micrometeorological technique that offers a new alternative to methods typically used to monitor volcanic fluxes. EC is a non-invasive, continuous, and spatially representative measurement technique that could help to improve global estimates of volcanic degassing. However, because volcanic terrain is often topographically complex, volcanic regions provide an extreme environment for EC.

An EC station was deployed at Solfatara volcano, Italy, June 8-25, 2001 to assess if EC could monitor CO_2 fluxes continuously at this site. EC fluxes of CO_2 were measured at six locations within Solfatara over the three-week period. EC fluxes calculated in 30-minute averages varied between 950 and 4460 g CO_2 m^{-2} d^{-1} depending on location. Comparing EC fluxes with chamber measurements of surface fluxes using footprint models yielded an average difference of 0 % (± 4 %), indicating EC measurements are representative of surface fluxes at this volcanic / hydrothermal site.

Reliable EC measurements (i.e., measurements with sufficient and stationary turbulence) were obtained primarily during daytime hours (08:00 and 20:00 local time). Daily average EC fluxes varied by ± 50 % as a function of atmospheric pressure. Variations in emissions due to volcanic processes at depth would have to exceed this diurnal variability in order to be useful to predict volcanic hazard. First-order models of magma emplacement suggest emissions could exceed this rate for reasonable assumptions of magma movement. EC therefore provides reliable estimates of surface fluxes at Solfatara, and should be considered as a new method to constrain global CO_2 budgets in future studies.

Antimony contamination in soil and ground water by shooting range activities

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Introduction

Antimony (Sb) occurs as minor component (≤ 3 %) in lead (Pb) alloys used for gun bullets. Because of high loading and toxicity of Sb in soils contaminated by firing activities it may pose a hazard to ground and surface waters. The fate and geochemistry of Sb in soils is poorly known. Our students, colleagues and we studied a number of contaminated soils and affected ground waters at various sites in Switzerland.

Results and Discussion

XRF analysis showed steadily decreasing contamination in soil down to 75 cm (see poster by Gresch et al.). Data from leachates and ground waters revealed the predominance of Sb(V) (> 95 %) relative to Sb(III) (< 5 %). For selected results from four different locations see the following table.

	Soil (< 0.5 mm) ppm	**Leachate** (solid/water = 0.1) µg/L	**Ground water** µg/L
Site Q	17’460	2900	2.0 - 3.2
Site D	1’881	4586	25.0 - 53.0
Site T	101	360	2.2 - 9.4
Site A	38	160	1.5 - 2.6

Results from sorption experiments in batch reactors with soil material performed at different solid/water ratios showed an S-shaped isotherm, which indicate a Langmuirian sorption behaviour at low Sb concentrations and solubility control at high Sb loadings. In the pH range 4 to 8, sorption showed no significant pH dependence. The dominant dissolved species under these conditions is $Sb(OH)_6^-$.

Significant increase in Sb concentration with respect to background was observed in the shallow ground waters underlying the studied sites (see Table). The modelling of the obtained sorption data using a simple one-dimensional reactive transport model with the code PHREEQC allowed a fairly good prediction of Sb levels in affected ground waters.

Conclusions

Sb released by contaminated soils has shown to be rather mobile due to rapid oxidation to Sb(V) and high solubility, thus affecting shallow aquifers. Further work including spectroscopic studies on the solid phase shall improve our understanding of the fate of Sb in soil and ground waters.