Volcanogenic acid deposition enhances weathering of Andisols in Nicaragua

PIERRE DELMELLE, MATHILDE PAQUE, LIONEL PIESSENS

Environmental sciences, Earth and Life Institute, Université catholique de Louvain, Croix du Sud 2, B-1348 Louvain-la-Neuve, Belgium.
pierre.delmelle@uclouvain.be

Sulphur and halogen-rich gas emissions from passively degassing volcanoes increase the acidity of the atmosphere and act as a source of acidifying compounds. In these environments, soils, which typically belong to the Andisol order, may be subjected to significant dry and wet deposition fluxes of SO_2, H_2SO_4, HCl and HF. Here we investigate the influence of a persistent tropospheric volcanic gas plume on soil chemical weathering. The study focuses on two soil transects affected by gas emissions from Masaya volcano, a basaltic caldera in Nicaragua. The last degassing unrest at Masaya started in mid-1993 and is on-going. We collected soil samples in 2017 and we assess their degree of weathering based on mineralogy and chemical characteristics. We contrast our results with the properties of soils studied sixteen years earlier (i.e. in 2001) and originating from the same sites [1,2]. The soils close to the volcano are younger, and less developed than those found farther away, consistent with the older dataset. However, all soils, irrespective of their development stage, show clear signs of increased weathering when compared to the soils collected in 2001. This trend is more marked in the soil surface horizons. We conclude that continuous volcanogenic acid deposition at Masaya enhances soil weathering within ~15 km of the source. In addition to the acids, the presence of fluoride in the volcanic gas emissions may increase the dissolution rates of the parent material's silicate glass and mineral consituents. Our findings also have ramifications for better understanding the environmental impacts of ancient large igneous province eruptions as these released huge amounts of sulphur- and halogen-rich gases over short periods of geologic time.

[1] Delmelle et al. (2003) Environmental Pollution, 126:445-457
[2] Delfosse et al. (2005) European Journal of Soil Science, 56:113-125