

In-Plume H₂O, CO₂, H₂S and SO₂ in the Fumarolic Field of La Fossa Cone (Vulcano Island, Aeolian Archipelago)

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Abstract : The periods of increased fumarolic activity at La Fossa volcano have been characterized, since early 80's, by changes in the gas chemistry and in the output rate of fumaroles. Excepting the direct measurements of the steam output from fumaroles performed from 1983 to 1995, the mass output of the single gas species has been recently measured, with various methods, only sporadically or for short periods. Since 2008, a scanning DOAS system is operating in the Palizzi area for the remote measurement of the in-plume SO₂ flux. On these grounds, the need of a cross-comparison of different methods for the in situ measurement of the output rate of different gas species is envisaged. In 2015, two field campaigns have been carried out, aimed at: 1. The mapping of the concentration of CO₂, H₂S and SO₂ in the fumarolic plume at 1 m from the surface, by using specific open-path diode tunable lasers (GasFinder Boreal Europe Ltd.) and an Active DOAS for SO₂, respectively; these measurements, coupled to simultaneous ultrasonic wind speed and meteorological data, have been elaborated to obtain the dispersion map and the output rate of single species in the overall fumarolic field; 2. The mapping of the concentrations of CO₂, H₂S, SO₂, H₂O in the fumarolic plume at 0.5 m from the soil, by using an integrated system, including IR spectrometers and specific electrochemical sensors; this has provided the concentration ratios of the analysed gas species and their distribution in the fumarolic field; 3. The in-fumarole sampling of vapour and measurement of the steam output, to validate the remote measurements. The dispersion map of CO₂, obtained from the tunable laser measurements, shows a maximum CO₂ concentration at 1m from the soil of 1000 ppmv along the rim, and 1800 ppmv in the inner slopes. As observed, the largest contribution derives from a wide fumarole of the inner-slope, despite its present outlet temperature of 230°C, almost 200°C lower than those measured at the rim fumaroles. Actually, fumaroles in the inner slopes are among those emitting the largest amount of magmatic vapour and, during the 1989-1991 crisis, reached the temperature of 690°C. The estimated CO₂ and H₂S fluxes are 400 t/d and 4.4 t/d, respectively. The coeval SO₂ flux, measured by the scanning DOAS system, is 9±1 t/d. The steam output, recomputed from CO₂ flux measurements, is about 2000 t/d. The various direct and remote methods (as described at points 1-3) have produced coherent results, which encourage to the use of daily and automatic DOAS SO₂ data, coupled with periodic in-plume measurements of different acidic gases, to obtain the total mass rates.

Keywords : DOAS, fumaroles, plume, tunable laser

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