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Soil CO_2 efflux monitoring by means of a static chambers alkaline traps network for the volcanic surveillance at Tenerife, Canary Islands

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Tenerife, the largest of the Canary Islands (2304 km^2), developed a central volcanic complex (Cañadas edifice) that started to grow about 3.5 My ago. The volcanic activity continued until the present along three rift zones oriented NW–SE, NE–SW and NS (hereinafter referred as NW, NE and NS rift-zones, respectively). Main volcanic historical activity has occurred along the NW and NE rift-zones, although the summit cone of Teide volcano located in central volcanic complex is the only area of the island where surface geothermal manifestations are visible. Uprising of deep-seated gases occurs along the aforementioned volcanic structures causing diffuse emissions at the surface environment of the rift-zones. In the last 20 years, there has been considerable interest in the study of diffuse degassing as a powerful tool in volcano monitoring programs.

Due to the absence of visible volcanic gases manifestations, diffuse degassing studies become a very important volcanic surveillance tool. Soil gas and diffuse degassing surveys in volcanic environments have historically been focused mainly on CO_2 because it is, after water vapor, the most abundant gas dissolved in magma. One of the most popular methods used to determine CO_2 fluxes in soil sciences is based on the absorption of CO_2 in an alkaline medium, in its solid or liquid form, followed by gravimetric, conductivity, or titration analyses.

In the summer of 2016, a network of 31 closed static chambers alkaline traps was installed, covering the three main structural zones of Tenerife (NE, NW and NS) as well as Cañadas Caldera with volcanic surveillance purposes. An aliquot of 50 mL of 0.1N KOH solution is placed inside the chamber to absorb the CO_2 released from the soil. The solution is replaced weekly and the trapped CO_2 is then analyzed at the laboratory by titration. They are expressed as weekly integrated CO_2efflux values. The CO_2 efflux values ranged from 2.3 to 16.0 g/m^2d^{-1}, with average values of 8.7 g/$m^2d^{-1}$for the NE rift-zone and 6.1 g/$m^2d^{-1}$for NW and NS rift-zones. The highest CO_2 efflux values were observed in the NE rift-zone. To investigate the origin of the soil CO_2 at the three volcanic rifts, soil gas samples were weekly taken on the head space of the closed chambers to study the chemical and isotopic composition of the CO_2. Collected gas samples can be considered as CO_2 enriched air, showing concentrations of CO_2 in the range 355-22,449 ppmV, with average values of 4,942 ppmV, 1,248 ppmV and 1,440 ppmV for the NE, NW and NS rift-zones, respectively. The CO_2 isotopic composition, expressed as δ^{13}C-CO_2, indicates that most of the sampling sites exhibited CO_2 composed by different mixing degrees between atmospheric and biogenic CO_2 with slight inputs of deep-seated CO_2, with mean values of -21.5‰ vs. VPDB, -14.1‰ vs. VPDB and -16.7‰ vs. VPDB for the NE, NW and NS rift-zones, respectively. The methodology presented here represents an inexpensive method that might help to detect early warning signals of future unrest episodes in Tenerife.