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Soil CO_2 efflux measurement network by means of closed static chambers to monitor volcanic activity at Tenerife, Canary Islands

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Tenerife (2304 km^2) is the largest of the Canary Islands and has developed a central volcanic complex (Cañadas edifice), that started to grow about 3.5 My ago. Coeval with the construction of the Cañadas edifice, shield basaltic volcanism continued until the present along three rift zones oriented NW–SE, NE–SW and NS (hereinafter referred as NW, NE and NS respectively). Main volcanic historical activity has occurred along de NW and NE rift-zones, although summit cone of Teide volcano, 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. Diffuse degassing studies are even more important volcanic surveillance tool at those volcanic areas where visible manifestations of volcanic gases are absent. Historically, soil gas and diffuse degassing surveys in volcanic environments have 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 through 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 was installed, covering the three main structural zones of Tenerife (NE, NW and NS) as well as Cañadas Caldera with volcanic surveillance porpoises. 50 cc 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. The are expressed as weekly integrated CO_2 efflux values. The CO_2 efflux values ranged from 3.2 to 12.9 $g \cdot m^{-2} \cdot d^{-1}$, with average values of 7.0 $g \cdot m^{-2} \cdot d^{-1}$ for the NE rift-zone and 6.4 $g \cdot m^{-2} \cdot d^{-1}$ for NW and NS rift-zones. The most significant CO_2 efflux values were observed in the NE rift-zone, with maximum values of 12.5 $g \cdot m^{-2} \cdot d^{-1}$. 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 composition and the 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 370-22,448 ppmV, with average values of 2,859 ppmV, 1,396 ppmV and 1,216 ppmV for the NE, NW and NS rift-zones, respectively. The CO_2isotopic composition, expressed as d^{xz}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 -17.5‰ -13.6‰ and -16.4‰ 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.