Geochemical monitoring of Cumbre Vieja volcano (Canary Islands) by summer diffuse CO₂ degassing surveys

Daniel Di Nardo¹,², Ellie-May Redfern³, Filippo Zummo⁴, Alba Martín-Lorenzo¹,², Claudia Rodríguez-Pérez¹, Eleazar Padrón¹,²,⁵, Gladys V. Melián¹,²,⁵, Lucía Sáez-Gabarrón¹, María Asensio-Ramos¹, Nemesio M. Pérez¹,², Pedro A. Hernández¹,²,⁵, Francisco A. Morales-González¹, and Lía Pitti-Pimienta¹,²

¹Instituto Volcanológico de Canarias (INVOLCAN), 38240 La Laguna, Tenerife, Canary Islands, Spain
(alex.dinardo.beca@iter.es)
²Instituto Tecnológico y de Energías Renovables (ITER), 38611 Granadilla de Abona, Tenerife, Canary Islands, Spain
³Department of Geography, Geology and the Environment, Keele University, Staffordshire, ST5 5BJ, U.K.
⁴Dipartimento Scienze della Terra e del Mare, Università Degli Studi di Palermo, Via Archirafi, 22, 90123 Palermo, Italy.
⁵Agencia Insular de la Energía de Tenerife (AIET), 38611 Granadilla de Abona, Tenerife, Canary Islands, Spain.

La Palma Island is the north-westernmost and one of the youngest of the Canarian Archipelago. In the last 123 ka, volcanic activity has taken place exclusively at Cumbre Vieja volcano which is located at the southern part of the island. Cumbre Vieja is characterized by a main north–south rift zone 20 km long and 1950 m in elevation covering an area of 220 km² with volcanic vents located northwest and northeast. Cumbre Vieja is the most active basaltic volcano in the Canaries with 7 historical eruptions, being Teneguía (1971) the most recent one. The most relevant volcanic activity episodes occurred since Teneguía eruption, are two intense seismic swarms occurred beneath Cumbre Vieja on 7-9 and 13-14 of October 2017. Since visible volcanic gas emissions do not occur at the surface of Cumbre Vieja, the geochemical surveillance program has been focused mainly on diffuse degassing studies. In the last 18 years diffuse CO₂ emission surveys have been yearly performed in summer periods to minimize the influence of meteorological variations. Measurements have been performed following the accumulation chamber method in about 600 sites and spatial distribution maps have been constructed following the sequential Gaussian simulation (sGs) procedure to quantify the diffuse CO₂ emission. Herein we summarize the diffuse CO₂ emission time series during this period and describe the results obtained in the last 2019 survey. The soil CO₂ efflux values measured in 2019 survey ranged from non-detectable to 72.7 gm⁻²d⁻¹. Diffuse CO₂ output was estimated in 1,064 ± 35 td⁻¹, a value within the background +1σ range (1,254 td⁻¹) (Padrón et al., 2015, Bull Volcanol. 77:28). In the period 2001-2017, the diffuse CO₂ output released to the atmosphere from Cumbre Vieja volcano ranged between 320 to 1,544 td⁻¹. Enhanced endogenous contributions of deep seated CO₂ might have been responsible for the higher CO₂ emission values measured in 2011 and 2013. After the October 2017 seismic swarms, diffuse CO₂ output showed an increasing trend from 788 to 3,251 td⁻¹ in March 2018, to decrease gradually until 852 td⁻¹ in September of that same year, and begin to gradually increase again to 2,371 td⁻¹ in November 2018. These changes were possibly caused by an upward magma
migration. Our results demonstrate that periodic surveys of diffuse CO$_2$ emission are extremely important for the detection of early warning signals of future volcanic unrest episodes at Cumbre Vieja.