



Environmental factors controlling diffuse CO₂ emission rates from Cumbre Vieja Volcano, La Palma, Canary Islands

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La Palma Island (708.3 km²) is located at the north-western end of the Canarian Archipelago and is one of the youngest island (~2.0My). During the last 123 ka, volcanic activity has taken place exclusively at the southern part of the island, where Cumbre Vieja volcano, the most active basaltic volcano in the Canaries, has been constructed. Seven historical eruptions have occurred at Cumbre Vieja, been Teneguía the last one (1971). On 7-14 of October 2017 and 10-15 November 2018, two intense seismic swarms occurred beneath Cumbre Vieja. In order to monitor the volcanic activity at Cumbre Vieja, main efforts have been focused on diffuse degassing studies since visible volcanic emissions are absent at the surface environment of this volcano. Diffuse CO₂ emissions have been monitored at Cumbre Vieja since 1997 in a yearly basis, with a higher frequency since the start of intense seismic swarms until August, 2019. At each survey, 600 sampling sites are selected for soil CO₂ efflux measurements performed in situ following the accumulation chamber method. Spatial distribution maps are constructed following the sequential Gaussian simulation (sGs) procedure and, to quantify the CO₂ emission from the studied area, 100 simulations are performed for each survey. At each sampling site, soil gas samples were collected at 40cm depth. Isotopic analysis of C in the CO₂ of selected soil gas samples (10% of the total) was performed to discriminate the origin of the CO₂. Between 2001 and 2017, the estimated diffuse CO₂ emission rate released to the atmosphere from Cumbre Vieja volcano has ranged between 320 to 1,544 td⁻¹. After October 2017 seismic swarms, diffuse CO₂ emission rates were estimated on a nearly daily basis, showing three increasing trends from 800td⁻¹ up to 3,251td⁻¹, 2,850td⁻¹ and 1,904td⁻¹, respectively. With the aim to filter out the effects of rainfall on the measured CO₂ efflux time series, a decorrelation pluviometric data analysis was performed. We found that a moving average of sixty days of the averaged rainfalls of six pluviometers on the studied area explained 49.4% of variability of diffuse CO₂ emission. The first peak on diffuse CO₂ emission remained after filtering, with a highest value of 2,020td⁻¹, when the time series had a non linear behaviour and the two seismic swarms occurred. Highest value of the second peak was 1,495td⁻¹ whereas the third peak practically disappears after filtering, due to the high influence with rainfall. Isotopic analysis of soil C-CO₂ showed enrichments in volcanic-hydrothermal CO₂ before the two mean peaks of filtered soil CO₂ emission time series. We found seismological and geochemical evidences that

these swarms were linked to a deep-seated magmatic intrusion. We hypothesize that the October 2017 seismic swarms were produced by an upward magma migration from an ephemeral magmatic reservoir located in the upper mantle (about 25 km depth), toward another reservoir located close to the Moho beneath Cumbre Vieja (12-15 km). The consequent depressurization of the magma batch was the source of the volatiles observed at the surface, with a delay of few weeks for CO₂.