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Monitoring diffuse CO_2 degassing in a monogenetic volcanic field during a quiescent period: the case of Timanfaya volcano (Lanzarote, Canary Islands, Spain)

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Lanzarote (795 km^2), the easternmost island of the Canarian archipelago, is located approximately 100 km W from the NW coast of Morocco, Africa. It experienced the largest historical eruption sequence of the Canary Islands between 1730 and 1736 in Timanfaya, Lanzarote, when long-term eruptions from a NE–SW-trending fissure (Marinoni and Pasquaré, 1994) formed the Montañas del Fuego and produced voluminous lava flows that covered a surface of 200 km^2. The last eruption at Lanzarote Island occurred in 1824 at Tinguaton volcano, and produced a small lava flow that reached the SW coast of the island. Since the 1730–1736 volcanic eruption, constant high ground temperatures are one of the most prominent geophysical phenomena of Timanfaya Volcanic Field (TVF). The main thermal anomalies are located in the area known as Islote de Hilario, 0.6 km to the NW of Timanfaya volcano (Hernández et al. 2012). Along the TVF fumarolic activity is absent at the surface, and therefore monitoring diffuse CO_2 efflux becomes a useful geochemical tool to monitor volcanic activity at this island.

To do so, since 1999, diffuse CO_2 emission surveys have been undertaken at TVF and surrounding areas almost in a yearly basis. At each survey, between 370 and 430 sampling sites were selected to obtain a homogeneous distribution over an area of 252 km^2. Soil CO_2 efflux measurements have been always performed in situ following the accumulation chamber method (Parkinson, 1981). In September 2017 a new survey was carried out at TVF with 410 sampling sites homogenously distributed along TVF always depending on logistic reasons. Soil CO_2 efflux values ranged from non-detectable to 5.3 $g{\cdot}m^{-2}{\cdot}d^{-1}$ with a maximum soil temperature of 295ºC measured at a depth of 40 cm. Statistical-graphical analysis of the data showed three different geochemical populations; background (B), intermediate (I) and peak (P), represented by 98.5%, 0.7% and 0.7% of the total data, respectively, with geometric means of 0.32, 3.28 and 4.9 $g{\cdot}m^{-2}{\cdot}d^{-1}$, respectively. Higher CO_2 efflux values were measured at the north sector of the TVF where thermal anomalies occur, suggesting a convective mechanism transport of gas from depth at these areas. To quantify the diffuse CO_2 emission rate from the TVF, 100 sequential Gaussian simulations (sGs) were performed as interpolation method to construct soil CO_2 emission contour maps. The diffuse CO_2 emission rate for the studied area was estimated in 61 $\pm$ 6 $t{\cdot}d^{-1}$, value lower than the background average of CO_2 emission, estimated in 121.4 t d^{-1}. This type of studies demonstrate the great utility of using diffuse CO_2 degassing as a useful geochemical method to contribute to volcanic monitoring programs in systems where there are no visible geothermal surface manifestations.