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Anomalous changes of diffuse CO_2 emission and seismic activity at Teide volcano, Tenerife, Canary Islands

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Tenerife (2034 km^2) is the largest of the Canary Islands and hosts four main active volcanic edifices: three volcanic rifts and a central volcanic complex, Las Cañadas, which is characterized by the eruption of differentiated magmas. Laying inside Las Cañadas a twin stratovolcanoes system, Pico Viejo and Teide, has been developed. Although there are no visible gas emanations along the volcanic rifts of Tenerife, the existence of a volcanic–hydrothermal system beneath Teide volcano is suggested by the occurrence of a weak fumarolic system, steamy ground and high rates of diffuse CO_2 degassing all around the summit cone of Teide. Soil CO_2 efflux surveys have been performed at the summit crater of Teide volcano since 1999, to determine the diffuse CO_2 emission from the summit crater and to evaluate the temporal variations of CO_2 efflux and their relationships with seismic–volcanic activity. Soil CO_2 efflux and soil temperature have been always measured at the same 38 observation sites homogeneously distributed within an area of about 6,972 m^2 inside the summit crater. Soil CO_2 diffuse effluxes were estimated according to the accumulation chamber method by means of a non-dispersive infrared (NDIR) LICOR-820 CO_2 analyzer. Historical seismic activity in Tenerife has been characterized by low- to moderate-magnitude events (M $<$2.5), and most of the earthquake's epicenters have been clustered in an offshore area SE of Tenerife. However, very few earthquakes have occurred in other areas, including Teide volcano. At 12:18 of January 6, 2017, the Canary Seismic Network belonged to the Instituto Volcanológico de Canarias (INVOLCAN) registered an earthquake of M 2.5 located in the vertical of Teide volcano with a depth of 6.6 km. It was the strongest earthquake located inside Cañadas caldera since 2004. Between October 11 and December 13, 2016, a continuous increase on the diffuse CO_2 emission was registered, from 21.3 $\pm$ 2.0 to 101.7 $\pm$ 20.7 t d^{-1}, suggesting the occurrence of future increase in the seismic-volcanic activity. In fact, this precursory signal preceded the occurrence of the 2.5 seismic event and no significant horizontal and vertical displacements were registered by the Canary GPS network belonged to INVOLCAN. This seismic event was probably due to the increase of fluid pressure in the hydrothermal-magmatic system of Tenerife. With the aim of investigate the relationship of the observed temporal variation on diffuse CO_2 emission and the seismic event occurred beneath Teide volcano in January 6, 2016, the anomalous peak of diffuse CO_2 emission was tested following the Material Failure Forecast Method (FFM). To do so, a Geochemical Window Precursory Signal (GWPS) was selected between October 11 and December 13, 2016. Plotting the inverse of diffuse CO_2 emission rate versus time, the interception of the linear fit of the data with the time axis indicates the theoretical moment when seismicity is most likely to occur. Surprisingly, interception of the linear fit occurred for a time window between January 6 and 9, 2017, showing an excellent correlation with the occurrence of the M 2.5 earthquake registered at Teide in January 6, 2017.