Geophysical Research Abstracts, Vol. 7, 05483, 2005
SRef-ID: 1607-7962/gra/EGU05-A-05483

Surface detection of subsurface magma movement by diffuse CO_2 degassing studies in and around the NW volcanic rift-zone at Tenerife, Canary Islands

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Tenerife's NW volcanic rift zone is part of a three-armed rift system of this oceanic island, where most of the volcanic activity have occurred. Fumarolic activity is absent along the NW rift-zone; therefore, diffuse CO_2 degassing studies constitute a major geochemical program for volcanic surveillance for this area. The first survey of diffuse CO_2 emission in and around the NW rift zone covering an area of 72 Km^2 was carried out during the summer of 2000, when no signatures of unrest were observed for this volcanic system. The total output of CO_2 emission was estimated about 76 td^{-1}. Background's CO_2 efflux geometric mean for this area is about 1 g$m^{-2}d^{-1}$, suggesting that background diffuse CO_2 emission value is about 72 td^{-1} for the study area. Later surveys carried out during the summer of 2003 and the first week of May 2004 showed a significant increase for the total diffuse CO_2 degassing output through the surface environment reaching estimated values of 138 and 410 td^{-1}, respectively. These geochemical observations support the idea of an unrest of the volcanic system, as it was also suggested by an anomalous seismic activity recorded in the area during April 22-29, 2004, by the National Spanish Seismic Network operated by IGN. On the May 11, 2004, and three days after the survey carried out during the first week of this month, an earthquake of 3.0 in magnitude was felt in the area, and the focus of seismicity was more superficial than those previous registered during the last week of April. After the first felt earthquake a new survey was carried out during the last week of May, and a total diffuse CO_2 output of 415 td^{-1} was estimated for the area. Later surveys during the summer showed a sharp decreasing trend on the total diffuse CO_2 emission in and around the NW rift zone reaching normal values by the middle of

September when a total diffuse CO_2 output of 74 td^{-1} was estimated. New surveys at a later date showed a different tendency, and an increasing trend of diffuse CO_2 emission has been observed reaching estimated values of 344 td^{-1}. Spatial distribution of soil CO_2 efflux values also showed changes in magnitude and amplitude, and the higher CO_2 efflux values were commonly located along an elongated area trending WNW-ESE. Subsurface magma movement is suggested for the observed changes in the total output of diffuse CO_2 emission as well as for the spatial distribution of soil CO_2 efflux. Geophysical observations such as seismicity patterns also support this hypothesis. Since the observed surface geochemical anomalies are spatially well correlated with major structural features of the study area, a magma driven fracture open at the NW rift zone of Tenerife during April-May 2004 could be a rationale model to explain the volcanic unrest at Tenerife. The actual increasing tendency of the total CO_2 output could suggest an increase of pressure in the volcanic-hydrothermal system. This process might trigger new dyke intrusions in the near future along the NW rift zone of Tenerife.