Geophysical Research Abstracts
Vol. 20, EGU2018-16634-2, 2018
EGU General Assembly 2018

Observed anomalous diffuse He and H_2 emission rates from the summit crater of Teide volcano, Tenerife, Canary Islands

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Monitoring diffuse degassing is becoming an important geochemical tool for volcanic surveillance. Tenerife (2034 km^2) 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 (Pérez et al., 2013). Most of the diffuse degassing studies on volcanic-hydrothermal systems are primarily focused on CO_2. However, few studies of surface He and H_2 efflux measurements in volcanoes have been performed. Diffuse He emission studies have recently provided promising results to detect changes related to volcanic unrest episodes (Padrón et al., 2013). The geochemical properties of He minimize the interaction of this noble gas on its movement towards the earth's surface. It is highly mobile, chemically inert, physically stable, non-biogenic, sparingly soluble in water under ambient conditions, and highly diffusive with a diffusion coefficient about 10 times that of CO_2. Hydrogen is one of the most abundant trace species in volcano-hydrothermal systems and is a key participant in many redox reactions occurring in the hydrothermal reservoir gas (Giggenbach 1987; Chiodini and Marini 1998). Because of its chemical and physical characteristics, such as low weight and low solubility in groundwater and hydrothermal fluids, H_2 moves rapidly within the crust and escapes easily to the atmosphere. These characteristics make H_2 a potentially excellent tracer of processes operating deep in magmatic systems. Surface He and H_2 efflux surveys have been performed at the summit crater of Teide volcano since 2009, to determine the diffuse He and H_2 emission rates from the summit crater and to evaluate the temporal variations and their relationships with seismic–volcanic activity. Surface He and H_2 efflux and have been measured at the same 38 observation sites homogeneously distributed within an area of 6,972 m^2 inside the summit crater. Estimated diffuse He emission values were lower than 0,2 $kg{\cdot}d^{-1}$ from 2009 to 2016. After this period an increase of the diffuse He emission has been observed reaching values of 1,4 $kg{\cdot}d^{-1}$. Similar pattern had been observed for the diffuse H_2 emission since its estimated values from 2009 to 2016 were mostly lower than 5 $kg{\cdot}d^{-1}$ showing emission rates about 20 $kg{\cdot}d^{-1}$ during the 2017. These observed anomalous diffuse He and H_2 emission rates from the summit crater of Teide volcano are well correlated to changes on the seismic activity at Tenerife. These geochemical observations seem to be clear evidences of changes of processes operating deep in the hydrothermal-magmatic system of Tenerife.

References

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