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Insights from fumarole gas geochemistry on the recent volcanic unrest of Pico do Fogo, Cape Verde

Gladys V. Melián[1,2], Pedro A. Hernández[1,2], María Asensio-Ramos[1], Nemesio M. Pérez[1,2], Eleazar Padrón[1], Mar Alonso[2], Germán D. Padilla[1], José Barrancos[1], Francesco Sortino[3], Hirochicka Sumino[4], Fátima Rodríguez[1], Cecilia Amonte[2], Sonia Silva[5], Nadir Cardoso[5], and José M. Pereira[6]

[1]Instituto Volcanólogico de Canarias (INVOLCAN), Granadilla de Abona, Tenerife, Canary Islands, Spain (gladys@iter.es)
[2]Instituto Tecnológico y de Energías Renovables (ITER), Granadilla de Abona, Tenerife, Canary Islands, Spain
[3]Istituto Nazionale di Geofisica e Vulcanologia - Sezione Roma 2. Via di Vigna Murata, 605 - 00143 Roma (Italia)
[4]Department of General Systems Studies, Graduate School of Arts and Sciences, The University of Tokyo, Komaba, Meguro-ku,Tokyo, Japan
[5]Universidade de Cabo Verde (UNICV), Praia, Santiago, Cape Verde
[6]Laboratório de Engenharia Civil of Cape Verde (LEC) Tira - Chapéu, Santiago, Praia, Cape Verde

The Cape Verde islands are located about 800 km west of Senegal, at 14°-17° latitude and 21°-25° longitude. The archipelago consists of a volcanic chain of 10 major islands and eight minor islands The only currently active volcano in the Cape Verde archipelago is Pico do Fogo, which is located on the island of Fogo. Rising to 2829 m a.s.l., it is the most active volcano of the Cabo Verde Island. We report the results of the geochemical monitoring of the fumarolic discharges at the Pico do Fogo volcano in Cape Verde from 2007 to 2016. During this period Pico do Fogo experienced a volcanic eruption (November 23, 2014) that lasted 77 days. Two fumaroles were sampled, a low (F1~100ºC) and a medium (F2~300ºC) temperature. The variations observed in the $\delta^{18}O$ and $\delta^{2}H$ in F1 and F2 suggest different fluid source contributions and/or fractionation processes. Although no significant changes were observed in the outlet fumarole temperatures, two clear increases were observed in the vapor fraction of fumarolic discharges during the periods 2008-2009 and 2013-2014. Also, two sharp peaks were observed in CO_2/CH_4 ratios at both fumaroles, in November 2008 and November 2013, coinciding with significant increases in the emission rate of diffuse CO_2 and He, and heat flow measured in the crater of Pico do Fogo volcano. This confirms that gases with a strong magmatic component rose towards the surface within the Pico do Fogo system during 2008 and 2013. Further, F2 showed two CO_2/St peaks, the first in late 2010 and the second after eruption onset, suggesting the occurrence of magmatic pulses into the volcanic system. Time series of He/CO_2, H_2/CO_2 and CO/CO_2 ratios are low in 2008-2009, and high in 2013-2014 period, supporting the hypothesis of fluid input from a deeper magmatic source. Regarding to the isotopic composition, increases in $^{3}He/^{4}He$ $(R/R_A)_{cor}$ are observed in both fumaroles; F1 showed a peak in 2010 from a minima in 2009 during the first magmatic reactivation onset and another in late 2013, while F2 displayed a slower rise to its maximum in late 2013. The high $^{3}He/^{4}He$ ratios in both fumaroles are close to the magmatic end-member, indicating that He is predominantly of upper mantle origin. This work supports that monitoring of the chemical and

isotopic composition of the fumaroles of the Pico do Fogo volcano is a very important tool to understand the processes that take place in the magmatic-hydrothermal system and to be able to predict future episodes of volcanic unrest and to mitigate volcanic risk.