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Monitoring diffuse He degassing from the summit crater of Pico do Fogo volcano, Cape Verde

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Fogo (476km^2) is one of the Sotavento islands of Cape Verde archipelago. The main geomorphological feature is the presence of a 9 km wide caldera hosting one of the world's most active volcanoes, Pico do Fogo (2829 m.a.s.l.), with the last eruption occurring on November 2014. Pico do Fogo volcano is characterized by the existence of a fumarolic field situated NW inside the summit crater and composed by low- and high-temperature gas discharges (90 to above 200^{o}C respectively) with widespread sulfur precipitates at the surface, typical of hydrothermal alteration. As part of the geochemical monitoring program for the volcanic surveillance of Fogo volcano, twelve surveys of diffuse Helium (He) emission through the surface of the crater have been performed since 2008. He emission has been measured because it is considered as an excellent geochemical indicator (Pogorsky and Quirt 1981) due to its geochemical properties. Recent results clearly show the importance of helium emission studies for the prediction of major volcanic events and the importance of continuous monitoring of this gas in active volcanic regions (Padrón et al. 2013). Soil He emission rates were measured always at the same 63 sampling sites distributed inside the crater and covering an area of 0.142km^2. At each measurement site, soil gas was collected in 10 cc glass vials with a hypodermic syringe by inserting to 40 cm depth a 50 cm stainless probe and later analyzed for He content by a quadrupole mass spectrometer Pfeiffer Omnistar 422. Diffusive and convective emission values were estimated at each sampling site following the Fick and Darcy's laws. The He emission rate through the crater was estimated after making the spatial interpolation maps using sequential Gaussian simulation. The average emission rate during these eight years of study is 3.3 kg d^{-1}. The emission rate showed an important increase (up to 5.7 kg d^{-1}) eight months before the 2014 eruption onset. During the eruptive period the crater released the highest value (up to 8 kg d^{-1}), followed by a decrease after the eruption. The last emission value was measured in October 2016 and represents the lowest value of the series (1 kg d^{-1}). This data suggest that monitoring of He degassing rate in volcanic areas is an excellent warning geochemical precursory signal for volcanic unrest. This work demonstrates and reinforces the importance of performing helium emission studies as an important promising volcano monitoring technique that might help to detect early warning signals of volcanic unrest in oceanic volcanic islands.