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Precursory signals of the 2014-15 Fogo eruption (Cape Verde) detected by surface CO_2 emission and heat flow observations

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On November 23, 2014 a new eruption occurred at Fogo volcano (Cape Verde) after 19 years of the last eruptive event in 1995. In the case of the 1995 Fogo eruption, a volcano monitoring program for the volcanic surveillance of Fogo did not exist. On the contrary, a simple and multidisciplinary volcano monitoring program was initiated since 2007 to detect early warning signals of a new volcanic unrest such as the 2014-15 Fogo eruption. Diffuse CO_2 emission surveys at the summit crater of Pico do Fogo volcano were periodically carried out from May 2007 to October 2014 to provide this multidisciplinary approach and to monitor potential volcanic activity changes. During this 7 year period, CO_2 efflux ranged from non detectable (< 1.5 g m-2 d-1) up to relatively high (61.9 kg m-2 d-1) values. The observed average δ13C- CO_2 values related to these diffuse CO_2 emission surveys ranged from –22.1 to 1.6 ‰ and surface heat flux measurements, following the method of Dawson (1964), showed also a wide range of values from 0.1 to 460 W m-2. Areas with the highest observed CO_2 efflux values were also characterized by a relatively high soil temperature and an intense surface hydrothermal alteration, which supports that degassing process is primary controlled by an advective mechanism generated by geothermal gradients (convection). Two periods of anomalous diffuse CO_2 emission were observed between February 2009 to February 2010 and March to August 2014, respectively. Rest of surveys showed the lowest variability on diffuse CO_2 emission, ranging from 23 to 186 t d-1 (average = 86 t d-1). The first anomalous period was characterized by a sharp increase on diffuse CO_2 emission, suggesting the first magma intrusion beneath Pico do Fogo volcano. This observation is also supported by a significant change on the δ13C- CO_2 signature from May 2009 (–10.2 ‰ to February 2010 (–6.1‰ of the diffuse CO_2 degassing, indicating an enrichment on the magmatic CO_2 component. On February 2010, the diffuse CO_2 emission rate was 219 $\pm$ 36 t d-1 (Dionis et al., 2015). The second anomalous period started on March 2014, eight months before the 2014-15 Fogo eruption onset, and reached a relatively high value of 337 $\pm$ 119 t d-1 on August 30, 2014. It was likely caused by rising of magmatic gases from a second magma intrusion which ended on an eruption. Heat flow temporal evolution during the observation period also shows a quasi-continuous increase before the eruption onset, with the maximum observed heat flow (16.4 $\pm$ 3.4 MW) on March 2014. These geochemical and geophysical evidences are clearly precursory signals of the 2014-15 Fogo eruption.

Dawson, G.B. (1964), N Z J Geol Geophys 7:155–171; Dionis S. et al. (2015), Bull. Volcanol., in press