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Soil gas 222Rn and volcanic activity at El Hierro (Canary Islands) before and after the 2011 submarine eruption

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El Hierro (278 km^2) is the southwesternmost island of the Canarian archipelago. From June 19, 2011 to January 2012, more than 11,950 seismic events have been detected by the seismic network of IGN. On 10 October 2011 the earthquake swarm changed its behaviour and produced a harmonic tremor due to magma movement, indicating that a submarine eruption located at 2 km south of La Restinga had started which is still in progress. Since 2003, the ITER Environmental Research Division now integrated in the Instituto Volcanológico de Canarias, INVOLCAN, has regularly performed soil gas surveys at El Hierro as a geochemical tool for volcanic surveillance. Among the investigated gases, soil gas radon (^{222}Rn) and thoron (^{220}Rn) have played a special attention. Both gases are characterized to ascend towards the surface mainly through cracks or faults via diffusion or advection, mechanisms dependent of both soil porosity and permeability, which in turn vary as a function of the stress/strain changes at depth. Years before the starts of the volcanic-seismic crisis on July 17, 2011, a volcanic multidisciplinary surveillance program was implemented at El Hierro including discrete and continuous measurements of ^{222}Rn and ^{220}Rn. Two soil gas ^{222}Rn surveys had been carried out at El Hierro in 2003 and 2011, and four continuous geochemical monitoring stations for ^{222}Rn and ^{220}Rn measurements had been installed (HIE02, HIE03, HIE04 and HIE08). Soil gas ^{222}Rn surveys were carried out at the surface environment of El Hierro after selecting 600 sampling observation sites (about 40 cm depth). Geochemical stations measure ^{222}Rn and ^{220}Rn activities by pumping the gas from a PVC pipe inserted 1m in the ground and thermally isolated. The results of the 2003 and 2011 soil gas ^{222}Rn surveys show clearly a relatively higher observed ^{222}Rn activities in the surface environment on 2011 than those observed on 2003 when no anomalous seismicity were taking place beneath El Hierro. The observed anomalous soil gas ^{222}Rn activities were mainly detected along the major volcano-structural features of the island. The time series recorded at HIE02 and HIE03 showed clear ^{222}Rn precursory signatures of the volcanic eruption. Observed ^{222}Rn activity ranged from negligible values to 16.5 and 1.6 $kBqm^{-3}$ at HIE02 and HIE03 stations, respectively. Individual ^{222}Rn peaks registered in both stations had been also very useful to forecast later pulses on the volcanic activity. In addition, ^{222}Rn/^{220}Rn ratios in both stations showed a strong increase prior the eruption.