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Diffuse degassing He/CO_2 ratio before and during the 2011-12 El Hierro submarine eruption, Canary Islands

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El Hierro Island (278 km2) is the youngest and the SW-most of the Canary Islands. On July 16, 2011, a seismic-volcanic crisis started with the occurrence of more than 11,900 seismic events and significant deformation along the island, culminating with the eruption onset in October 12. Since at El Hierro Islands there are not any surface geothermal manifestation (fumaroles, etc), we have focused our studies on soil degassing surveys. Between July 2011 to March 2012, seventeen diffuse CO_2 and He emissions soil gas surveys were undertaken at El Hierro volcanic system (600 observation sites) with the aim to investigate the relationship between their temporal variations and the volcanic activity (Padrón et al., 2013; Melián et al., 2014). Based on the diffuse He/CO_2 emission ratio, a sharp increase before the eruption onset was observed, reaching the maximum value on September 26 ($6.8 \times 10\text{-}5$), sixteen days before the occurrence of the eruption. This increase coincided with an increase in seismic energy release during the volcanic unrest and occurred together with an increase on the 3He/4He isotopic ratio in groundwaters from a well in El Hierro Island (Padrón et al., 2013; from 2–3 RA to 7.2 RA where RA = 3He/4He ratio in air), one month prior to the eruption onset. Early degassing of new gas-rich magma batch at depth could explain the observed increase on the He/CO_2 ratio, causing a preferential partitioning of CO_2 in the gas phase with respect to the He, due to the lower solubility of CO_2 than that of He in basaltic magmas. During the eruptive period (October 2011-March 2012) the prevalence of a magmatic CO_2-dominated component is evident, as indicated by the generally lower He/CO_2 ratios and high 3He/4He values (Padrón et al., 2013). The onset of the submarine eruption might have produced a sudden release of volcanic gases, and consequently, a decrease in the volcanic gas pressure of the magma bodies moving beneath the island, reflected by a drastic decrease in the diffuse helium emissions measured after the eruption onset. Therefore, this study shows that higher diffuse He/CO_2 emission ratios preceded the 2011–2012 El Hierro submarine eruption, clearly show the critical role that both gas species can play in the prediction of major volcanic events and demonstrates the importance of performing soil He and CO_2 surveys as a useful geochemical monitoring tool in active volcanic regions.

Padrón et al. (2013) Geology 41(5), 539-542; Melián et al. (2014) JGR, 119: 6976-6991, doi:10.1002/2014JB011013