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# Diffuse $CO_2$ degassing monitoring of the oceanic active volcanic island of El Hierro, Canary Islands, Spain

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Even during repose periods, volcanoes release large amounts of gases from both visible (fumaroles, solfataras, plumes) and non-visible emanations (diffuse degassing). In the last 20 years, there has been considerable interest in the study of diffuse degassing as a powerful tool in volcano monitoring programs, particularly in those volcanic areas where there are no visible volcanic-hydrothermal gas emissions. Historically, soil gas and diffuse degassing surveys in volcanic environments have focused mainly on $CO_2$ because it is, after water vapor, the most abundant gas dissolved in magma. As $CO_2$ travels upward by advective-diffusive transport mechanisms and manifests itself at the surface, changes in its flux pattern over time provide important information for monitoring volcanic and seismic activity. Since 1998, diffuse $CO_2$ emission has been monitored at El Hierro Island, the smallest and south westernmost island of the Canarian archipelago with an area of 278 $km^2$. As no visible emanations occur at the surface environment of El Hierro, diffuse degassing studies have become the most useful geochemical tool to monitor the volcanic activity in this volcanic island. The island experienced a volcano-seismic unrest that began in July 2011, characterized by the location of a large number of relatively small earthquakes (M<2.5) beneath El Hierro at depths between 8 and 15 km. On October 12, 2011, a submarine eruption was confirmed during the afternoon of October 12, 2011 by visual observations off the coast of El Hierro, about 2 km south of the small village of La Restinga in the southernmost part of the island. During the pre-eruptive and eruptive periods, the time series of the diffuse $CO_2$ emission released by the whole island experienced two significant increases. The first started almost 2 weeks before the onset of the submarine eruption, reflecting a clear geochemical anomaly in $CO_2$ emission, most likely due to increasing release of deep seated magmatic gases to the surface. The second one, between October 24 and November 27, 2011, before the most energetic seismic events of the volcanic-seismic unrest (Melián et al., 2014. J. Geophys. Res. Solid Earth, 119, 6976–6991). The highest $CO_2$ degassing rate measured in the last three years (1684 t/d) was observed during a seismo-volcanic unrest. This value decreased until close to background value (∼422 t/d, Melián et al., 2014) contemporaneously with the decline of the seismic activity during the first half of 2013. The last diffuse $CO_2$ degassing survey was carried out in the summer of 2016, showing a emission rate of 854 t/d. Discrete surveys of diffuse $CO_2$ emission have provided important information to optimize the early warning system in the volcano monitoring programs of El Hierro and to monitor the evolution of an ongoing volcanic eruption, even though is a submarine eruption.