Soil gas physical-chemistry survey for geothermal exploration at Terceira Island, Azores.

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Terceira Island is located in the Azores Archipelago and it lies at the intersection of four submarine volcanic ridges. Due to its characteristics the geothermal potential of Terceira Island has begun to receive some interest from researchers and decision makers from the 70s of last century, but only in 2000 an exploration license was granted in favour of GEOTERCEIRA (now EDA RENOVÁVEIS S.A.). The area of this license is located in the central part of the island in the Pico Alto Volcanic Complex, and includes the fumarolic field of Furnas do Enxofre.

The main aim of this study is to provide additional information about the presence of fluids upflow regions and areas of increased subsurface permeability related to high temperature hydrothermal activity at depth, as part of an study to expand the current geothermal plant of Terceira. To achieve this objective, a soil gas and diffuse CO₂ and H₂S degassing survey, which included in situ CO₂ emission measurements and soil temperature at 15 and 40 cm deep and the collection of soil gas samples, was performed during September 2019. 122 sampling sites were selected spaced at ~100 meters at Pico Alto Volcanic Complex. Diffuse CO₂ and H₂S measurements were performed according to the accumulation chamber method, using a non-dispersive infrared (NDIR) LICOR-830 CO₂ analyser and ALPHASENSE H₂S-BH detectors, respectively. In addition, soil gas samples were collected to analyse the He, H₂, O₂, N₂, CO₂, CH₄ and CO contents and the isotopic composition of the CO₂. Soil CO₂ efflux values ranged between non-detectable values and 56.2 g m⁻² d⁻¹, with an average of 21.7 g m⁻² d⁻¹. Soil H₂S efflux values ranged between non-detectable values and 0.245 g m⁻² d⁻¹, with an average of 0.027 g m⁻² d⁻¹. The probability plot technique applied to the soil CO₂ efflux data allowed to distinguish three different geochemical populations: background, intermediate and peak represented by 36.9 %, 59.8 % and 3.3 % respectively, with geometric means of 10.8, 25.4 and 50.0 g m⁻² d⁻¹ respectively. The spatial distribution of soil CO₂ efflux data, constructed by means of Sequential Gaussian simulations algorithm, depicted the most important emission anomalies at the western section of the study area. These results can help to identify the
possible existence of additional actively degassing geothermal reservoirs to reduce the uncertainty inherent to the selection of the area with the highest potential success in the selection of new exploratory wells at Terceira.