Diffuse H₂ and He degassing survey to study of hidden potential geothermal systems in La Palma, Canary Islands

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La Palma is one of the eastern islands of the Canary Archipelago located off the West African continental margin. Volcanic activity in the last 123 ka has taken place exclusively at the southern part of the island, where Cumbre Vieja volcano has been formed. Cumbre Vieja, one of the most active basaltic volcano in the Canaries, host seven historical eruptions being Teneguía eruption (1971) the most recent one. Cumbre Vieja volcano, characterized by a main north–south rift zone 20 km long and covering an area of 220 km², does not show any visible degassing that show the existence of active geothermal systems. For that reason, geochemical prospecting of soil gases and volatiles in the soil matrix itself of Cumbre Vieja can provide useful information to investigate the presence of permeable areas and potential upflow areas for the degassing of geothermal systems at depth.

We report herein the results of an intensive soil gas study, focused on non-reactive and/or highly mobile gases such as helium (He) and hydrogen (H₂), in Cumbre Vieja, with geothermal exploration purposes. He has unique characteristics as a geochemical tracer: it is chemically inert and radioactively stable, non-biogenic, highly mobile and relatively insoluble in water. H₂ is one of the most abundant trace species in volcano-hydrothermal systems and is a key participant in many redox reactions occurring in the hydrothermal reservoir gas.

Soil gas samples were collected at 1,201 sites selected from June 2019 to September 2019, with an average distance between sites of ≈ 250 m, at ≈ 40 cm depth using a metallic probe. He content was analyzed by means of a quadrupole mass spectrometer (QMS; Pfeiffer Omnistar 422) and hydrogen concentrations by a micro-gas chromatograph (microGC; VARIAN CP490). Soil He concentration showed values up to 23.9 ppm with an average of 5.73 ppm. Soil H₂ concentrations measured ranged from typical atmospheric values (≈ 0.5 ppm) up to 19.8 ppm. The mean value measured for H₂ was 0.78 ppm. Although He concentration values showed high spatial variability, the highest values can be observed in the north–south rift zone of Cumbre Vieja and around the
surface contact with Cumbre Nueva ridge. Spatial distribution of H$_2$ concentration showed the highest values in the north-west area of Cumbre Vieja volcano. The results showed here are useful to identify the possible existence of permeable portions of deep-seated actively degassing geothermal reservoirs. However, a multidisciplinary approach is essential to obtain additional information about possible geothermal systems underlying at Palma island with the last goal of the selection of appropriate locations for future exploratory wells.