Geothermal prospecting at Cumbre Vieja volcano (La Palma, Canary Islands) by ground radon and thoron measurements

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During geothermal exploration, the geochemical methods play a major role in both exploration and exploitation phases. Discovery of new geothermal systems requires exploration of areas where the resources are either hidden or lie at great depths. A good example of young volcanic territory with high geothermal potential where geothermal resources are either hidden or lie at great depths is La Palma island (Canary Islands). La Palma is one of the youngest and westernmost island of the Canarian archipelago, located at the West African continental margin. Cumbre Vieja volcano (220 km²) is the last stage in the geological evolution of the island and has suffered 8 volcanic eruptions in the last 500 years, the last one in 1971. Among geochemical methods for geothermal exploration, soil gas surveys are useful for delineating main upflow regions and areas of increased subsurface permeability related to high temperature hydrothermal activity at depth. Soil gas Rn surveys are particularly useful since it is a naturally occurring radioactive gas present in geofluids that may serve as a subsurface tracer of geothermal reservoirs. An intensive soil gas was carried out from June to September 2019 in order to study the potential geothermal resource in Cumbre Vieja and the presence of vertical permeability structures related to high temperature hydrothermal reservoirs. A total of 1200 samples were taken with an average distance between sites of ≈250 m. Soil gas Rn-222 activity were measured by means of a portable SARAD RTM 2010-2 radon monitor; the instrument pumped gas through a stainless steel probe inserted at 40 cm depth and measured the Rn activity by electrostatic detection of the positively charged daughter isotopes. The soil gas Rn values ranged from atmospheric levels to 8.7 kBq m⁻³, with an average of 1.5 kBq m⁻³. The spatial distribution of soil Rn displays enrichments along the three main volcanic-rift zones: N-S, N-W and N-E, and confirms a strong structural control in the degassing processes of the volcano. The three volcanic-rift areas are zones of enhanced permeability for deep gas migration and preferential routes for degassing. It is worth noting the presence of an important soil gas Rn anomaly located at the eastern part of Cumbre Vieja, out of the three volcanic-rift areas. The data presented here are important to identify main upflow regions and areas of
increased and deep permeability at Cumbre Vieja.