Quantification of the CO_2 emitted from volcanic lakes in Pico Island (Azores)

César Andrade (1), José Cruz (1), Fátima Viveiros (1), Rafael Branco (1,2)

(1) Research Institute for Volcanology and Risk Assessment, Ponta Delgada, Portugal, (2) Centre for Information and Seismovolcanic Surveillance Azores, University of the Azores Apartado, 1422 9501-801 Ponta Delgada, Portugal

This study shows the results of the diffuse CO_2 degassing surveys performed in lakes from Pico volcanic Island (Azores archipelago, Portugal). Detailed flux measurements using the accumulation chamber method were made at six lakes (Capitão, Caiado, Paul, Rosada, Peixinho and Negra) during two field campaigns, respectively, in winter (February 2016) and late summer (September 2016). Pico is the second largest island of the Azores archipelago with an area of 444.8 km2; the oldest volcanic unit is dated from about 300,000 years ago. The edification of Pico was mainly due to Hawaiian and Strombolian type volcanic activity, resulting in pahoehoe and aa lava flows of basaltic nature, as well as scoria and spatter cones. Three main volcanic complexes are identified in the island, namely (1) the so-called Montanha Volcanic Complex, corresponding to a central volcano located in the western side of the island that reaches a maximum altitude of 2351 m, (2) the São Roque-Piedade Volcanic Complex, and (3) the Topo-Lajes Volcanic Complex, this last one corresponding to the remnants of a shield volcano located in the south coast.

The studied lakes are spread along the São Roque-Piedade Volcanic Complex at altitudes between 785 m and 898 m. Three are associated with depressions of undifferentiated origin (Caiado, Peixinho, Negra), two with depressions of tectonic origin (Capitão, Paul), while Rosada lake is located inside a scoria cone crater.

The lakes surface areas vary between 1.25x10-2 and 5.38x10-2 km2, and the water column maximum depth is 7.9 m (3.5-7.9 m). The water storage ranges between ∼3.6x104 to ∼9.1x104 m3, and the estimated residence time does not exceed 1.8x10-1 years.

A total of 1579 CO_2 flux measurements were made during both surveys (868 in summer and 711 in the winter campaign), namely 518 in Caiado lake (293; 225), 358 in Paul (195; 163), 279 in Capitão (150, 129), 200 in Rosada (106, 94), 171 in Peixinho (71, 100) and 53 measurements in Negra lake. Negra Lake was only sampled in the summer season.

The CO_2 flux values range between 0.68 g m-2 d-1 (Paul lake) and 20.47 g m-2 d-1 (Negra). The total CO_2 emission varies between 0.03 t d-1 (Negra and Peixinho lakes) and 0.30 t d-1 (Caiado lake) for the summer surveys, and between 0.04 t d-1 (Rosada lake) and 0.26 t d-1 (Caiado lake) for the winter data.

The higher CO_2 emission is observed for Rosada lake (8.89 t km-2 d-1) during summer and the lower corresponds to the Negra lake (1.67 t km-2 d-1) during summer. Considering the set of the studied volcanic lakes, the CO_2 emission sums up to ∼64 t d-1 (winter campaign) and ∼72 t d-1 (summer). These emissions are probably mainly associated to a biogenic source, but the characterization of the CO_2 emission in these volcanic lakes during periods of quiescence is relevant for any seismo-volcanic monitoring programme.

Key words: volcanic lakes, CO_2 flux, diffuse degassing, Pico Island, Azores