Natural gamma radiation in La Palma Island, Canary Islands, Spain

María López-Pérez1, Pedro Ángel Salazar-Carballo1,2, M. Candelaria Martín-Luis3, José Miguel Lorenzo-Salazar1, Xiomara Duarte-Rodríguez1, Antonio Catalán-Acosta1,2, Álvaro Gijón-Aguado1, and José Hernández-Armas1

1Universidad de La Laguna, Laboratorio de Física Médica y Radioactividad Ambiental, SEGAI, Spain (mlopezpe@ull.edu.es)
2Universidad de La Laguna, Departamento de Medicina Física y Farmacología, Spain (psalazar@ull.edu.es)
3Universidad de La Laguna, Departamento Biología Animal, Edafología y Geología, Spain (mcmartin@ull.es)

The Canary Islands are an archipelago with an area of 7,447 km² comprising seven main islands and some islets, located about 90 km off the northwest coast of Africa. La Palma is the most active volcanic island of the Canarian archipelago in historical times (after XV Century), with an area of 706 km² and about 83,000 inhabitants. From the geochemical point of view, La Palma is characterized by alkaline rocks ranging from basanites and alkali picrites to phonolites. Despite the different geological units essentially overlap in their bulk chemical compositions, there are significant differences.

Measurements of natural gamma radiation were carried out in 71 sites randomly selected on a predefined 3x3 km sampling grid covering the whole island in 2013. Total outdoor gamma radiation levels were measured at 1 m above the ground. Air gamma radiation was measured by means of a MINI 6-80 (Mini-Instruments) monitor equipped with an energy-compensated Geiger-Müller MC-71 probe and FH 40 GL 10 (ThermoFischer Scientific) dosimeter equipped with a proportional-gas detector. The background radiation was calculated for each sampling site and subtracted for each dose measurement. Additionally, 25 soil samples were collected at a depth of 0-15 cm in uncultivated fields. Radiometric measurements for $^{40}$K, $^{226}$Ra and $^{232}$Th radioisotopes were performed by low-level gamma spectrometry with coaxial-type germanium detectors (Canberra Industries Inc., USA).

The gamma absorbed dose rates showed a log-normal distribution, ranging from 37.2 up to 134.0 nGy·h$^{-1}$, with a geometric mean of 64.5 nGy·h$^{-1}$. The observed mean gamma absorbed dose rate in La Palma Island was higher than those measured in La Gomera Island (43.9 nGy·h$^{-1}$), and lower than those measured in Tenerife (89.2 nGy·h$^{-1}$) and El Hierro islands (93.3 nGy·h$^{-1}$) (publication in preparation). The geometric means of $^{40}$K, $^{226}$Ra and $^{232}$Th activity concentration were 216.1 Bq·Kg$^{-1}$, 22.0 Bq·Kg$^{-1}$ and 23.6 Bq·Kg$^{-1}$, respectively.

Maps with the spatial distribution of the terrestrial natural gamma radiation and $^{40}$K, $^{226}$Ra and $^{232}$Th radioisotopes were also prepared and compared with the geochemical composition of soils. Contour maps for the terrestrial radiation component of the absorbed dose rate and radioisotope distributions were obtained using ordinary Kriging interpolation. Lower absorbed dose rates
(between 45 and 70 nGy h$^{-1}$) were observed in the oldest northern part of the island, corresponding to the Taburiente and Garafía basaltic shields. Two anomalies were found with absorbed dose rate values between 80 and 110 nGy h$^{-1}$. The first one is located at the Bejenado stratovolcano, extending north to the Caldera de Taburiente, and south to the Aridane Valley. The second anomaly was found in the southeastern part of the Cumbre Vieja ridge. This last volcanic edifice corresponds to the youngest part of the island, where several historical eruptions have occurred. These anomalies might be related to phonotephritic and phonolitic rocks identified at the upper part of the Bejenado sequence and Cumbre Vieja edifice.