Gamma-spectrum analysis of neutron activated sand samples

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Espírito Santo state has an extensive anomalous area that stretches from the coast of Rio de Janeiro to the coast of Bahia state, with a high concentration of rare earth elements and thorium. One of those responsible for such a condition is the presence of the monazite mineral [1]. The literature presents sand samples analyses regarding samples that originated from Guarapari, a city of Espírito Santo state considered an HBRA (High Background Radiation Areas) [2]. One of the reasons for this condition is its soil formation, which presents about 2/3 of the soils originating from granite and gneiss rocks [3]. Such rocks have a high concentration of U238, Th-232 and K-40, elements that most contribute to the exposure of human beings to natural ionizing radiation [2,3]. Gamma spectrometry is a non-destructive technique that allows to identify and quantify the concentrations of radionuclides emitting gamma radiation present in a sample without making rigorous treatments on the samples before measurement [4]. Also, the neutron activation technique is based on nuclear processes where the elements that make up the sample, when irradiated by neutrons, become excited and emit gamma radiation [5]. This technique converts stable nuclei into radionuclides, and these, in turn, emit radiation that can be used to identify and quantify the elements that make up samples [5]. The Argonauta research reactor, its facilities and staff, offer suitable conditions to allow both neutron activation and gamma spectrometry of sand samples [6]. Regarding the relevance of ionizing radiation exposure to humans, there are still further reasons to evaluate the activity of U238, Th-232 and K-40 at the Guarapari's sand. This work aims to apply the gamma spectrometry technique to determine the activity concentrations of the elements K-40, Ra-226 and Ra-228 and compare the activity concentration values and associated effective dose with the literature. Moreover, this work intends to apply the neutron activation technique to identify and quantify rare earth and other elements present in the samples. To characterize this material and quantify the rare earth elements, whose concentration is globally unique, is of relevance. In this work, sand samples were collected at Guarapari's beaches. The places of samples collecting were georeferenced with the use of GPS. The samples were dried in an oven at 40 °C for 48 hours, sieved with a 2 mm nylon sieve, placed in 120 ml poly(ethylene) flasks, sealed and stored for 30 days to achieve secular balance. The next step is to neutron-activate these samples in the Argonauta research reactor. Afterwards, these samples will be counted on a detection system composed of a high resolution spectrometer, a semiconductor detector of hyperpure germanium (HPGe), with a relative efficiency of 20 % and model GEMF5930 from ORTEC.

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