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ANALYSIS OF THE VERTICAL DISTRIBUTION AND THE SIZE FRACTIONATION OF NATURAL AND ARTIFICIAL RADIONUCLIDES IN THE SOIL IN THE VICINITY OF HOT SPRINGS

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Lead-210 is a naturally occurring radionuclide of great importance for environmental studies. Its vertical distribution in the soil, combined with that of ²²⁶Ra, may provide useful information on the radon released to the atmosphere in the region, due to soil radon exhalation, or radon carried by ground water. Previous research has shown that natural radioactivity levels –in particular ²¹⁰Pb and ²²⁶Ra activity in the ground –may be higher near hot springs^[1].
In this work, two different locations near hot springs were selected for soil sampling: Kamena Vourla and Thermopylae in Greece. Depending on the special soil characteristics of each sampling location, it was decided to collect soil cores up to a depth of 22 cm from Kamena Vourla, and surface soil from Thermopylae. The soil cores were separated by 1 cm pitch, while the surface soil samples were separated into seven particle size fractions by dry sieving, using a sieving machine and sieves in the range of 0.045-2 mm. All samples were analyzed at the Nuclear Engineering Department of the National Technical University of Athens, by high resolution gamma-ray spectrometry, using an XtRa germanium detector and a Low Energy germanium detector, to determine: (a) the terrestrial natural radionuclides ²³⁴Th, ²²⁶Ra, ²¹⁰Pb, ²²⁸Ra, ²²⁸Th, ⁴⁰K, (b) the cosmogenic radionuclide ⁷Be, and (c) the artificial radionuclides ¹³⁷Cs and ¹⁰⁶Ru. It is worth mentioning that the ¹⁰⁶Ru that was detected in samples collected from both locations is the result of an accidental release over Europe, a few days before the sampling took place.
The vertical profile of the radionuclides obtained from the core sample analysis indicated a disturbance in the first 7 cm of the soil, while at greater depth the concentrations for all radionuclides were as expected. Lead-210 activity was higher than that of ²²⁶Ra, showing a disruption in the radioactive equilibrium, as expected. The analysis of the size-fractionated samples showed –as expected –a higher activity concentration for ²¹⁰Pb and ¹³⁷Cs in the finer fractions. The radioactive equilibrium between ²³⁴Th, ²²⁶Ra, ²¹⁰Pb was found to be significantly disturbed in all size fractions, suggesting that the cause was mainly hot spring water periodically flooding the sampling terrain.

[1] Beitollahi M, Ghiassi-Nejad M, Esmaeli A, Dunker R. 2007. Radiological studies in the hot spring region of Mahallat, Central Iran. Radiat Prot Dosim 123(4), 505–508

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