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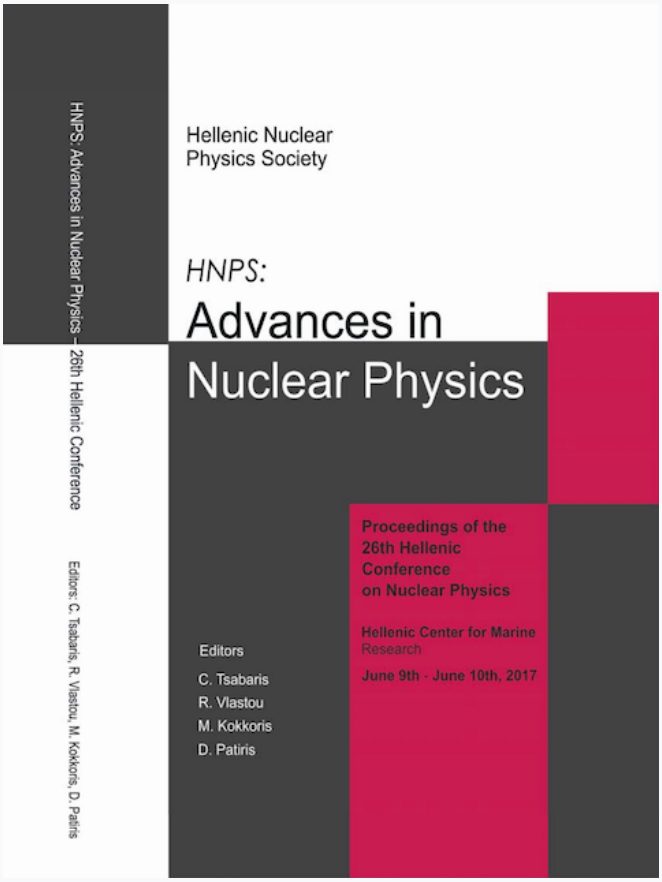

Measurement and spectroscopic analysis of background radiation of UoA campus using the AMESOS mobile specrometer

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Measurement and spectroscopic analysis of background radiation of UoA campus using the AMESOS mobile spectrometer

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Abstract Environmental radioactivity measurements are considered very important for assessing the impact of natural and artificial radiation on human population. In the present work, the AMESOS mobile gamma spectrometer was deployed in the largest university campus in Athens (UoA Zografou Campus) to perform in situ radioactivity measurements at several locations, spanning its full area. Spectra were analyzed offline focusing on the natural decay series of ^{238}U and ^{232}Th, but also ^{40}K and the artificial ^{137}Cs. The mobile spectrometer was carefully calibrated to comply with international standards for such measurements. The results were subsequently combined to geospatial data to generate detailed maps of radioactivity for the UoA campus. In addition, a respective dose-rate map was created to estimate the risk for campus employees, students and visitors (est. over 30'000 on a daily basis). A correlation of natural radioactivity levels to the geological horizon of the area is also in the works.

Keywords natural radioactivity, mobile spectrometer, AMESOS

INTRODUCTION

Environmental radioactivity studies offer invaluable information on the levels of human exposure to natural and man-made radiation. In this project, a full-scale charting of radiation levels in the premises of University of Athens in Zografou Campus, the largest metropolitan campus in the country, was undertaken for the first time, by means of mobile γ-spectroscopy.

A significant number of locations inside the UoA Campus, mainly on undisturbed grounds, were selected for performing in situ measurements. Besides estimating NORM levels (^{238}U,^{40}K) in the soils, traces of ^{137}Cs from the 1986 Chernobyl accident were searched in the spectra.

EXPERIMENTAL DETAILS

The *in situ* measurements were carried out using the AMESOS mobile spectrometer [1] (a 3"x3" NaI(Tl) detector with a DigiBase, mounted on a custom-made tripod up to 1.65m high). The detector was USB-connected to a laptop. A portable Magellan GPS system was used to record the exact coordinates of each location.

Fig. 1. Map of the UoA campus with the sampling locations

All measurements were performed in situ. A total of twenty (20) locations were selected in advance to ensure optimal coverage of the Campus area (Fig.1). Prior to each measurement, the region under and around the detector was cleansed of leaves and large obstacles. Each measurement lasted an average of 3 uninterrupted hours. Collected data were then analyzed offline using XSA [2] and SpectrW [3]. The independent analyses were then combined to produce weighted averages.

In a previous study [1] the AMESOS spectrometer had been fully characterized for a distance of 10 cm from the ground. To obtain a more representative spectrum for extended areas, AMESOS was raised to a height of 1.50 m. An absolute efficiency curve was obtained (Fig. 2) along with the radial sensitivity (Fig. 3) by using standard point-like sources (^{22}Na, ^{60}Co, ^{137}Cs) of known activities. The radial sensitivity study aimed at estimating the limits of the spectrometer in recording γ rays from distant sources. To a very good approximation, the resulting curve in Fig. 3 shows AMESOS is sensitive up to a maximum angle $\theta=\tan^{-1}(4/3)$ with respect to the vertical direction. This is equivalent to a circular area with a diameter of 2m from where recorded events originate. As a result, surface activities (in kBq/m^2) were obtained.

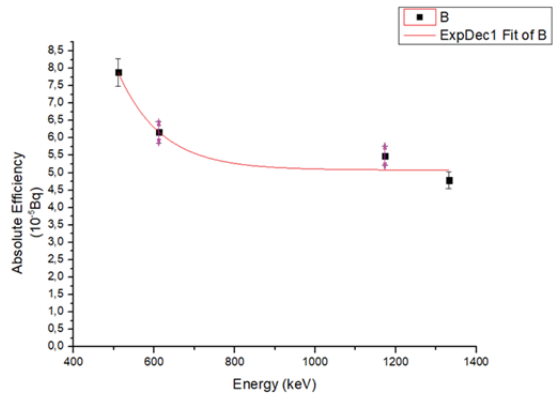

Fig. 2. Absolute efficiency curve

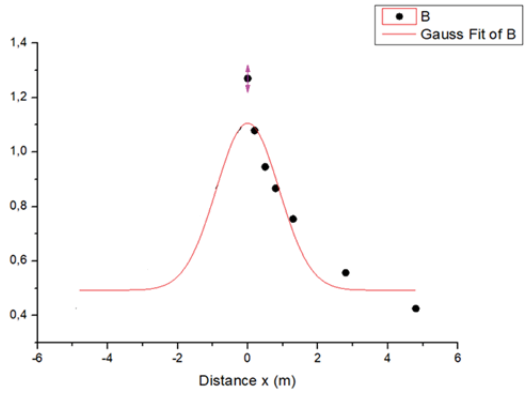

Fig. 3. Radial sensitivity measurements

RESULTS AND DISCUSSION

From the final results, radioactivity distribution maps were created (Figs. 4-6). Focus was given on naturally occurring ^{40}K (20-60 kBq/m^2), ^{238}U (via its daughter ^{214}Bi: 2-4 kBq/m^2), and also on the man-made ^{137}Cs (~1-3 kBq/m^2; ~50% of locations gave values below detection limit – b.d.l.). These results overall agree with existing literature data for Attica region.^{137}Cs is b.d.l. along the NE-SW border, where a waterkill exists and intense washout was expected (Fig. 6).

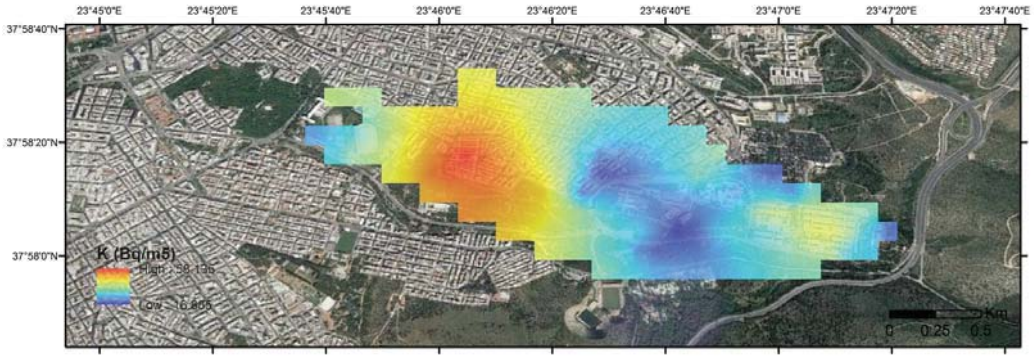

Fig. 4. ^{40}K radioactivity distribution map

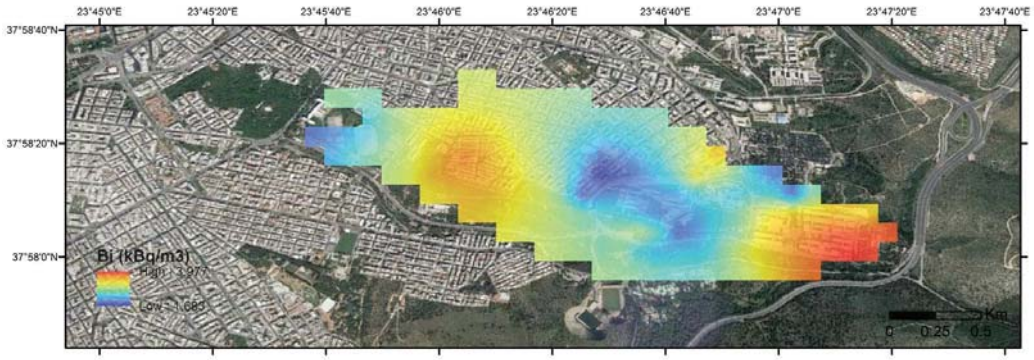

Fig. 5. ^{214}Bi radioactivity distribution map

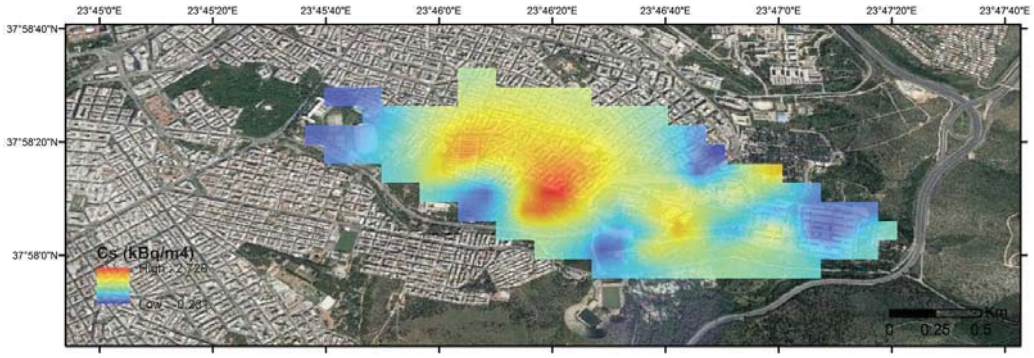

Fig. 6. ^{137}Cs radioactivity distribution map

CONCLUSIONS

The first-ever radioactivity maps of the UoA campus were created using AMESOS for in situ γ-ray spectrometry measurements. AMESOS was fully characterized and is ready to be deployed in the field. The present results agree with the typical background radiation levels in Attica region. Some traces of Chernobyl fallout are still present in the soils. Future analysis will combine the geological horizon of the area with the present radioactivity results. Equivalent dose rates will also be produced.

Acknowledgments

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References

[1] A. Karailias et al., HNPS2015 Proceedings Volume
[2] G.Kumbartzki, url: http://www.physics.rutgers.edu/~kum/sa.html (unpublished)
[3] C.A.Kalfas et al., NIM A 830, 265 (2016)
[4] Nucléide–Lara: Library for gamma and alpha emissions, url: http://www.nucleide.org/Laraweb/
[5] G.Gilmore, Practical Gamma-Ray Spectrometry, Wiley & Sons (2011)