



## Radiation dose Estimation: An in vitro Measurement for Isparta-Turkey

İskender AKKURT<sup>1\*</sup>, N. Ayten UYANIK<sup>2</sup>, Kadir GÜNOĞLU<sup>2</sup>

<sup>1</sup>Suleyman Demirel University, Science Faculty, Isparta-TURKEY

<sup>2</sup>Suleyman Demirel University, Technical Vocational School, Isparta-TURKEY

\* Corresponding Author : iskenderakkurt@sdu.edu.tr

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**Abstract:** People have always been exposed to radiation and it is important to determine this radiation dose for radioactive contamination. The main source for this radiation is from earth and it can change with the geological structure. Isparta is an interesting area as it is Angle connects the Aegean-West Anatolian extensional section and it is bordered by two major fault zones. Thus radiation dose have been measured in vitro (in situ) in this area. The measurement has been performed using gamma spectrometer (GF Instruments) fitted with an NaI(Tl) scintillator detector. The spectrum can separate gamma rays due to the <sup>238</sup>U, <sup>234</sup>Th and <sup>40</sup>K and measure activity. From the in vitro measurements of radioactivity and absorbed dose, the annual effective dose (E<sub>d</sub>) and radium equivalent activities (Ra<sub>eq</sub>) were also obtained.

### 1. Introduction

The human-being is always exposed to ionizing radiation due to background radiation which has been existed since big-bang due to long half-live of the natural radioelement found in the earth's crust. This is called natural radioactivity and total background radiation can be obtained adding man-made radiation to natural one. The main radioactive nuclides are <sup>226</sup>Ra, <sup>232</sup>Th and <sup>40</sup>K and they can be found almost in all types of rocks, granite, sand, cement and gypsum from which building materials are produced. The natural radiation is the main contributor to the external dose of the population and it is important to assess the gamma radiation dose from natural sources. The specific activities of radionuclides in river sediments mainly depend on geological, geographical and geochemical conditions of the materials. The activities of the radionuclides also depend on human economic and technological activities, etc. [1]. There are many studies in the literature due to be cause to serious health problems in humans the radiation levels of natural materials. Therefore, many researchers have measured the radiation levels of building construction materials in different countries [2-10].

Uyanik et al. [11] have been measured in situ for natural radiation levels of soil-originated bricks, roof-tiles and their raw material in the Salihli-Turgutlu area using a gamma-ray spectrometer. They have been determined the annual dose rate and radium equivalent activity values of the brick and roof-tiles in the range 0.42 - 0.62 mSv y<sup>-1</sup> and 172.9–245.2 Bq/kg, respectively.

Due to their important effects on human health, natural radioactivity levels in settlement areas should be determined by conducting in-situ measurements. The natural radioactivity levels present in soil and rock are due to the presence of radioelements, including uranium (238U), thorium (232Th) and potassium (40K). Radiometry is one of the most powerful and rapid methods to obtain information about the distribution and concentration of radionuclides (eU, eTh and K (%)) at any location [2]. Thus some previous researches [12-17] using this method indicate that it is also possible to perform radiological hazard, geological, geotechnical and geochemical mapping of a study area.

In this study in vitro radiation dose estimation was given and some results from the measurement performed in Isparta-Turkey will be discussed.

## 2. Materials and Methods

In situ measurement were performed using a portable gamma-ray spectrometer (1024 channels) fitted with an BGO (Bismuth German Dioxide) detector [2,11,18]. The gamma ray spectrometer is shown in Fig.1 and it can separate gamma rays produced by the elements of  $^{40}\text{K}$ ,  $^{238}\text{U}$  and  $^{232}\text{Th}$ . The measurement were performed at about 300 locations in Golcuk area of Isparta-Turkey. The measurements as detailed by Uyanik et al [2] were performed on the soil surface and took approximately 5 min each [2].

There are 4 different geological units in the study area. These units are Trachyandesite, Alluvium, Flysch and Limestone. The gamma ray spectrometer measurements have been performed in these geological units.



Figure 1. gamma ray spectrometer.

From the measured activity concentration the radium-equivalent activity ( $Ra_{eq}$ ) defined by Beretka and Mathew [19] were used to assess the risks presented by gamma radiation and given equation 1 and 2.

$$Ra_{eq} = A_U + \left(\frac{1}{0.7}\right)A_{Th} + \left(\frac{1}{13}\right)A_K \quad (1)$$

where  $A_U$ ,  $A_{Th}$  and  $A_K$  are the average activity concentrations of  $^{238}\text{U}$ ,  $^{232}\text{Th}$  and  $^{40}\text{K}$  in Bq/kg, respectively.

From the measured absorbed dose rate effective dose rate has been obtained using equation 2.

$$E_d(\mu\text{Sv}/y) = D \left(\frac{n\text{Gy}}{h}\right) 8760 \left(\frac{h}{y}\right) 0,2 \times 0,7 \left(\frac{\text{Sv}}{\text{Gy}}\right) 10^{-3} \quad (2)$$

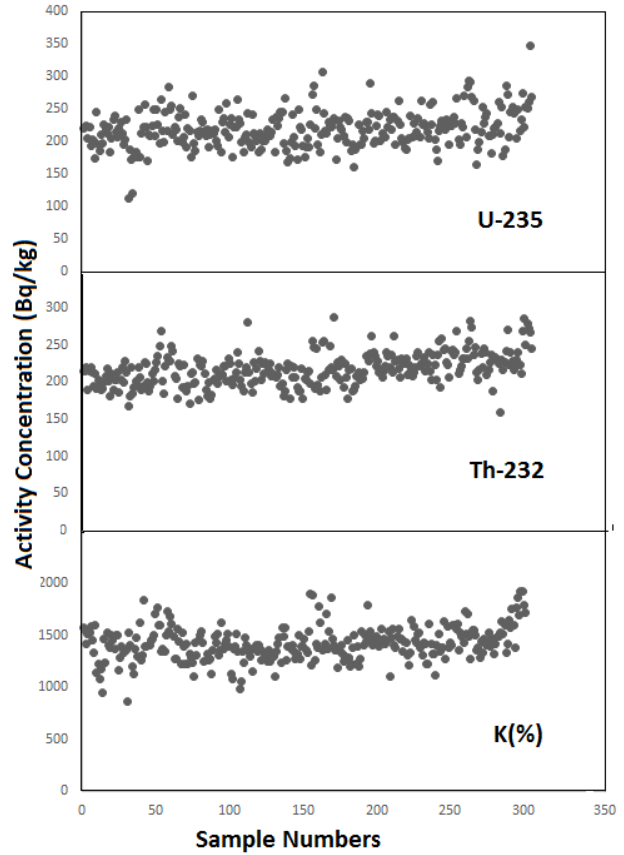


Figure 2. Results of activity concentration of U-Th-K.

In the effective dose rate ( $E_d$ ) the absorbed dose was multiplied by a dose conversion factor of 0.7 Sv/Gy and an outdoor occupancy factor of 0.2 [20].

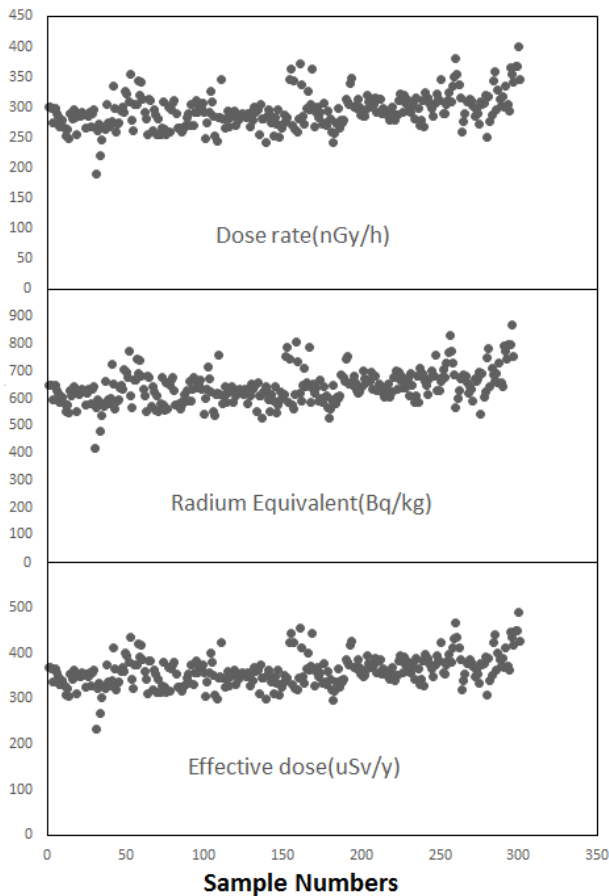
## 3. Results

Radiation dose estimation has been done using in situ measurement. Measurements have been performed in golcuk area of Isparta. The activity distribution of  $^{238}\text{U}$ ,  $^{232}\text{Th}$  and  $^{40}\text{K}$  has been obtained and results are displayed in Fig 2. In this figure activity concentration of  $^{238}\text{U}$ ,  $^{232}\text{Th}$  and  $^{40}\text{K}$  can be seen for about 300 local point. It can be seen from this figure that as expected K(%) is higher

than others. From the measurement of radioactivity concentration dose rate,  $R_{eq}$ ,  $E_d$  have been obtained and displayed in fig. 3. It can be seen from this figure that the obtained dose are under below radiation dose limit.

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**Figure 3.** Obtained radiometric parameter such as dose rate, radium equivalent and effective dose.

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