Estimation of surface exhalation rate of thoron (^{220}Rn) in soil samples of Aravalli Mountain range region of district Mahendergarh Haryana, India using alpha detector Smart Rnduo

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Introduction

Human beings are continuously exposed to natural radiation such as terrestrial radiation sources. These radiations are produced by the natural breakdown of rocks, soil, vegetation, other natural radioactive decay, etc. Alpha rays released from natural radionuclide of Radium (^{226}Rn) decay series found in soil, water, and rocks are terrestrial radiation. The radionuclide Radon (^{222}Rn) and Thoron (^{220}Rn) are generated from Radium (^{226}Rn) in the series of Uranium-238[1,2]. These radionuclides have the potential to migrate into soil and other natural process and give radiological health hazards to human beings [3]. Thoron reaches the environment from soil to indoor or outdoor atmosphere by two different methods: The emanation method and the exhalation method. The emanation power of Thoron depends on various factors such as the concentration of parent radionuclide ^{226}Rn in soil, rocks, geographical area, building material, etc. Since the half-life of thoron is very short (55.6secs), only surface soil contributes to the indoor environment [4]. For determining the surface exhalation rate in building materials, rocks, and geographical areas, characterization techniques have been reported. Among these major techniques, are the active technique and passive technique. Thoron (^{220}Th) is an isotope of Radon, having activity concentrations in rocks, water, and soil that are comparable to Radon. Thoron is the gas that emanates from bearing minerals and comes from radium isotope ^{224}Rn. Thoron decay emits an alpha particle having an energy of 6.3 MeV. The origin of the Thoron in the environment is from the top surface of the soil. So, it is of utmost importance to find out the concentration of radionuclide in soil samples. The study has been carried out by following the protocols of BARC Mumbai, India. The present research discusses the evaluation of Radionuclide Thoron surface exhalation rate in soil samples of the District Mahendergarh of Haryana, India. In context to its geology, this place is near the Khetri copper mines and in the range of 'Aravalli Hills, unique rocks and illegal mining in this area are the primary conditions of motivation for researching this particular area, also first time study has been carried out, no data has been recorded earlier.

Experimental details

For the determination of surface exhalation rate in soil samples in the present study, we have followed the standard protocols [5]. To search out/ examine, the concentration value of Thoron, in the exhalation chamber as in fig. 1,

Fig.1 Smart RnDuo detector

samples were analysed, the total for 1 hour, having 15 minutes per cycle period. The ^{220}Th surface exhalation rate in the soil is estimated from the following equation:

$$J_{st} = \frac{C_t V \lambda}{A}$$

Where J_{st} is the thoron surface exhalation rate inside the accumulator (Bq/m^2/s)
C_t is the thoron concentration measured by closing the surface exhalation chamber (Bq/m^3)
V is the residual air volume occupied in the exhalation chamber(m^3)
λ is the radioactive decay constant(s^{-1}) having a value (0.012464 s^{-1})
A is the surface area of the sample(m^2)

Results and discussion

The present study is focused on the surface exhalation rate of soil for district Mahendergarh of the Aravalli range and the results are as follows shown in table 1**.** Thoron and radon are the radioactive decay product that may be the cause of lung cancer according to BEIR VI (1999) [6]. Inhalation of short-lived decay products of ^{220}Rn and deposition along airways of the bronchial tree provide a pathway for radiation exposure to the lungs. The maximum exhalation rate of Thoron has been reported in Madhogarh rock (hilly area) (0.57724±0.08304) mBq/m^2/s. The minimum concentration of Thoron exhalation rate (0.08457±0.00998) mBq/m^2/s (Milli becquerel per square meter per second) was measured in the Pali surface region and the mean value of the concentration of Thoron has been studied (0.2940 ±0.04502) mBq/m^2/s. The surface exhalation rate concentration of thoron for district Mahendergarh, Haryana results are summarized in Table 1. The highest concentration of Thoron (^{220}Rn) was reported in Madhogarh rock soil, as according to the district survey report here granites, quartzite, and arsenopyrite are present this is the main reason for the highest concentration of radionuclide in soil sample have been reported. Granites have comparatively high thorium content. According to our study, we can differentiate surface soil from hilly area soil, as in hilly areas concentration of thorium was greater as compared to surface area (without any minerals). According to UNSCEAR 2000 report, the worldwide average value of surface exhalation rate of thoron (^{220}Rn) in soil samples is 1000 mBq/m^2/s. So, the present area lies within a safe limit, and the exhalation rate of the thoron has less value. A positive correlation was observed between thorium content in rocks and the surface exhalation rate of thoron (^{220}Rn).

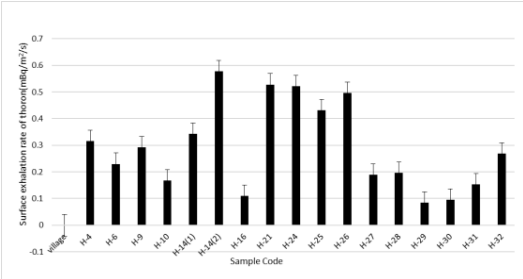

Table 1: Surface exhalation rate of Thoron in soil samples of the study area using alpha detector SMART RnDuo

References

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