ACTIVITY CONCENTRATION OF Ra-226 IN AGRICULTURAL SOILS

S. AKYIL, S. AYTAS, M. A. A. ASLANI, M. ERAL

Ege University, Institute of Nuclear Sciences, 35100 Bornova-IZMIR/TURKEY

ABSTRACT

The distribution of ^{226}Ra in agricultural soils has been studied. Twenty four soil samples were collected to a depth of 20 cm from Aegean Region of Turkey. Activity concentrations of ^{226}Ra in samples were determined by a radioanalytical method and measured by using an alpha scintillation detector. The radioanalytical method has been applied for the soil of 1 g to determine of this radioisotope concentration. The both detection and chemical efficiencies were performed using standard radioactive solution of Ra-226. The recovery yield of radiochemically pure ^{226}Ra was found to be 90%. The average concentration of ^{226}Ra were 0.186 Bq/g and their distribution fitted a normal curve. The data obtained was evaluated to explain of ^{226}Ra distribution in the agricultural area and compared with the other results in the literature.

INTRODUCTION

The well-known radiotoxicity of ^{226}Ra results from (1) the chemical similarity of radium to calcium, which allows a localization of ^{226}Ra in bone tissue when ingested; (2) the long physical (1600 years) and biological (1.64×10^4 days, bone) half-life of radium; and (3) alpha-particle emission from the decay of ^{226}Ra and from four of its radioactive progeny (^{222}Rn, ^{218}Po, ^{214}Po and ^{210}Po).[1-3]

^{226}Ra is presented in varying concentrations in all soils, rock and naturally occurring bodies of water, and its distribution in the environment is wide spread. Also ^{226}Ra is absorbed from soil by food crops and is hence incorporated into the food chain of man.[2]

The purpose of this study was to determine the ^{226}Ra activity concentration by a radiochemical method and to present an overview of its distribution in agricultural soil in Buyuk Menderes Basin which is one of the most important plain in Aegean Region of Turkey and has agricultural lands and localities, and the biggest river in the Aegean Region flows along the study area. This area was selected considering the great importance in agricultural lands for the region. There is no information about the activity concentration of ^{226}Ra for this area in the literature.

Special attention was paid to sites where high radiation levels were suspected because of the geological considerations and known uranium anomalies identified by some researchers (Ref.) in Western of the Basin. The average grade of these uranium deposits in the Basin is ranged from 0.02 to 0.08%. This study summarizes the results of ^{226}Ra activity concentrations measured at the selected sites and average absorbed dose rate.[4]

MATERIAL AND METHOD

Approximately 5 kg of soil were taken from each one of the 24 sampling sites. Firstly the soil was dried at ambient temperature, placed in an oven at 105°C for 24 hours and then sieved and homogenized prior to analyses. 1 g of prepared sample was weighted for radiochemical separation of ^{226}Ra. After the separation process, the radioactivity of ^{226}Ra was determined by alpha particle counting in a ZnS(Ag) scintillation detector.

^{226}Ra Determination:

A conventional radiochemical method to determine of ^{226}Ra was used. After waiting for about 20 days for ^{224}Ra decay, soil samples were dissolved with H_2SO_4 and HNO_3 acid mixture. Barium carrier was added to the acid solution. $Ba(Ra)SO_4$ was precipitated, centrifuged, washed with some H_2SO_4 and distillated water and then dissolved in EDTA. $(NH_4)_2SO_4$ was used to precipitate $Ba(Ra)SO_4$ again. After filtering and drying, the precipitate was counted by a ZnS(Ag) alpha scintillation detector.[5] The counting efficiency was carried out by using radioactive source ^{241}Am and found to be 32.29±0.50%. Chemical yield of the procedure was found to be 90.02±2.74% by using ^{226}Ra standard solution.

RESULTS AND DISCUSSION

The results showed that there is detectable ^{226}Ra activities in collected soil samples. The activity concentrations of ^{226}Ra ranged from 0.087 to 0.298 Bq/g. In general, mean ^{226}Ra activity was found as 0.186 Bq/g. The highest ^{226}Ra activity concentration was found in agricultural soils in Milet. The lowest activity concentration was observed as 0.087 Bq/g in Incirliova and Nesetiye.

It was observed that ^{226}Ra activity concentration along the costline and around Milet was slightly high. Such a high activity concentration can be explained by the fact that there is an uranium anomaly of 0.05% U_3O_8 in South-West of Soke District. There are known uranium anomalies in Western of Buyuk Menderes Basin. The reason of somewhat higher concentration of ^{226}Ra can be explained by the anomalies.

Kocarli-Kucukcavdar uranium deposit is in a very small neogene basin in augen gneiss. It contains 424 tones uranium at an average grade of 0.05% U_3O_8. Aydin-Demirtepe uranium deposit is emplaced in fracture zones in gneiss. It contains an estimated 1102 tones uranium at an average grade of 0.08% U_3O_8.[6] The slightly high activity concentration of ^{226}Ra in this study area is attributable to small uranium deposit and used fertilizer in the agricultural area.

The ^{226}Ra activity levels are generally higher in the coastal area of the Western Buyuk Menderes Delta as compared to inland sites. The ^{226}Ra concentrations in the soil samples can be attributed to the soil type and to the distribution of uranium anomalies is different in this region.

CONCLUSION

The main conclusion to be drawn, based on an analysis of the results presented in this study, is that the change of activity concentration of ^{226}Ra. It is unclear whether the activity concentration of ^{226}Ra have been affected by the use of fertilizer or by the absence of small uranium anomalies in this region. Further investigation would be necessary to explain difference in the activity concentration of ^{226}Ra in this area. It is planned to get information about the kind of used fertilizer in the agricultural land to assess ^{226}Ra concentration in the soil.

The association of the radionuclides in the soil solution with soil organic matter will undoubtedly have effects on their mobility and biological availability. Distribution coefficients K_d should be determined to interpret or to predict the behaviour of radionuclides in the soil.

Biogeochemical peculiarities of the migrations of heavy natural radionuclides in the environment are determined by their chemical properties and half-lives, the physicochemical properties of the environment, and the peculiarities of the sources and environmental pathways of the radionuclides.

ACKNOWLEDGEMENT

The authors would like to thank Ege University Research Foundation and TUBITAK (The Scientific and Technical Research Council of Turkey). The project is supported by a contract (Project No: 2000 NBE 002) by Ege University Research Foundation and (Project No: YDABCAG-100Y057) by TUBITAK.

REFERENCES

1. UNSCEAR Report, Sources and Effects of Ionizing Radiation, 1993.
2. IAEA, The Environmental Behaviour of Radium, Vol.1, Technical Reports Series No.310 1990.
3. Natural Radiation Environment III, Volume 1, Proceedings, Editors: Thomas F. Gesell, Wayne M. Lowder, Technical Information Center/U.S. Department of Energy, 1980.
4. Turkiye'nin Uranyum ve Toryum Kaynaklarinin Degerlendirilmesi Semineri, Proceedings, 23-26 May, Ankara, 1983 (in Turkish).
5. Testa C., Desideri D., Mell M. A., Roselli C., Bassignani A., Finazzi P. B., J. Radioanal. Nucl. Chem., Vol.170, No.1, 117-124, 1993.
6. OECD Report, Uranium Resources Production and Demand, Paris, 1990