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DETERMINATION OF ENVIRONMENTAL RADIOACTIVITY OF DRINKING WATER, SOIL AND AIR IN EDREMIT GULF SHORES

ABSTRACT

This study was investigated on soil and water samples taken from Northern Aegean Edremit Gulf shores (Edremit, Akcay, Altinoluk, Kucukkuyu) and air measurements at one-meter height from the land is also soil and drinking water taken from area. World Health Organization advises 0.1 Bq/l for gross alpha and 1.0 Bq/l for gross beta activity as limit values for drinking water. Turkish Standardization Institute also accepts these limits. Basic levels of natural radiation point out some changes related with the geological and geomorphologic features of the region. The mineralogical structures of rocks and soil and geographical height affect the natural background radiation level of the region. As methods is gross alpha and beta counting of the water samples taken from municipal supplies was performed by using a gas-flow proportional counter and the results values were presented in Bq/l. Soil samples, were analyzed by using a gamma-ray spectrometry system in Çekmece Nuclear Research And Training Centre laboratories. Air tested air HPGe detector.

Keywords: Edremit, Environment, Radioactivity, Pollution, Geographical Factors

EDREMİT KÖRFEZ KIYILARINDA HAVA, TOPRAK VE İÇME SUYUNDA ÇEVRESEL RADYOAKTİVİTENİN SAPTANMASI

ÖZET

Bu çalışma toprak, su ve hava örnekleri Kuzey Ege Edremit Körfezi kıyılarından (Edremit, Akçay, Altınoluk, Küçükkuyu), hava örnekleri yerden 1m yükseklikten ve aynı zamanda toprak ve içme suyu örneklerinde yapılmıştır. Dünya Sağlık Örgütü önerileri alfa ve beta 0.1 Bq/l sınır değerleri mevcut olup içme sularında bu değerler aşılmamıştır. Bu değerler aynı zamanda Türk Standartları Enstitüsünce de kabul edilmektedir. Bu bölgedeki doğal radyasyon düzeyleri jeolojik ve jeomorfolojik yapıya bağlı olarak doğal radyasyonun noktasal değişimleri ortaya çıkmıştır. Bölgedeki toprak ve kayaçların mineralojik yapısı ve coğrafi yeryüzü şekilleri doğal backgraund radyasyonu yüksek düzeyde etkilemektedir. Metot olarak belediyeliklerden alınan örneklerin Gross Alfa ve beta ölçümleri gas-flow ölçüm fotometresinde ölçülerek Bq/l olarak sunulmuştur. Toprak örnekleri ise Çekmece nükleer araştırma merkezi laboratuarlarında gamma-ray spektrometresinde, hava ölçüm metodu ise HPGe detektörüne uygulanması şeklinde olmuştur.

Anahtar Kelimeler: Edremit, Çevre, Radyoaktivite, Kirlilik, Coğrafi Faktörler

1. INTRODUCTION (GİRİŞ)

The natural radioactive nuclides, always present in the environment, are of two general classes: the cosmogenic and the primordial. The cosmogenic radionuclides are the beyond of this study. One can refer to ref. (Anonymous 1, Anonymous 2, Anonymous 3) for more information from United Nations Scientific Committee.

Naturally occurring radionuclides of terrestrial origin, also called primordial radionuclides, are present in various degrees in all media in the environment. Among the primordial radionuclides, the main contributors to external exposure are ^{40}K, and the radioactive series headed by ^{238}U and ^{232}Th. ^{40}K, ^{238}U and ^{232}Th are long-lived radionuclides that have existed in the earth's crust throughout its history. These radionuclides are also present in the body and irradiate the various organs with alpha and beta particles, as well as gamma rays. Some other terrestrial radionuclides, including those of ^{235}U series, ^{87}Rb, ^{138}La, ^{147}Sm and ^{176}Lu, exist in nature but at such low levels that their contributions to the dose in human are small (Anonymous 2) affected.

^{238}U and ^{232}Th are each the head of a decay series of more than ten nuclides. The ^{238}U and the ^{232}Th series can be classified in the sub series in which the activity of the precursors to a large degree controls the activities of the decay products. The detail of ^{238}U and ^{232}Th series are given in ionizing radiation (Anonymous 1).

The concentration of the primordial radionuclides in soil is determined by the radioactivity of the source rock and by the nature of the processes, which had been involved in the formation of the soil. Certain sedimentary rocks, notably some shale and phosphate rocks are highly radioactive. The main factor influencing the concentration of the natural radionuclides in soil is not the soil-forming process but the corresponding concentration in the soil - forming rocks. This process occurs by attachment to the exposed exterior surfaces of the stacked plate structures in clay minerals, as well as on the weathered "frayed edge" sites on their edges (Shaw and Bell, 2001 and Hilton and Comans, 2001). This fixing of radiocaesium in agricultural soils was demonstrated clearly by a series of lysimeter and pot experiments conducted at Imperial College in the early 1980s (Grogan et al., 1987). For instance: A large database, containing around 7700 individual soil to plant transfer factors, has been assembled by the International Union of Radioecology (lUR), in which the rooting depth is defined as 20 cm for agricultural crops and 10 cm for pasture grasses (Bell et al., 1988).

The concentration of the radionuclides in soil is directly relevant to the outdoor exposure. In recent years, several surveys have been performed over whole countries and areas for the purpose of estimating the exposure of the populations of those countries and areas to natural radiation. The surveys were conducted using various methods and types of instrumentation. Related data are given in references (Anonymous 1, Anonymous 2, Anonymous 3). This paper is also an example of such survey conducted in Turkey.

2. RESEARCH SIGNIFICANCE (ÇALIŞMANIN ÖNEMİ)

Determining natural radiation level of any region or location means investigating that place from the point of radiology, in other words determining the radioactivity being in water, air and soil of that place. In this study also, air, soil and water samples for healthy life. Samples are collected from different points of coastline of Edremit Buy, which is a human habitat in the region of Aegean in Turkey, were investigated and their radioactivity concentrations were determined suc as Tekirdağ (Yarar Y.,Kam.E. 2005) and Gaziantep (Osmanlioglu A.E.,Kam E. and Bozkurt A. 2007) region.

3. MATERIALS AND METHOD (MALZEME VE YÖNTEM)

Gross alpha and beta counting of the main drinking water samples taken from Edremit, Akçay, Altınoluk, Küçükkuyu municipal supplies fountains was performed by using a gas-flow proportional counter and the results were presented in Bq /m3. Soil samples, collected from different points in the area were analyzed by using a gamma-ray spectrometry, connected with an HPGe detector and the radioactivity concentrations of the elements of ^{40}K and ^{137}Cs (Uranium and Thorium series), were determined as nGy h-1 in Table 1. Measurements were made in air at 1 m height from the ground. (All samples device were in Fig.1.).

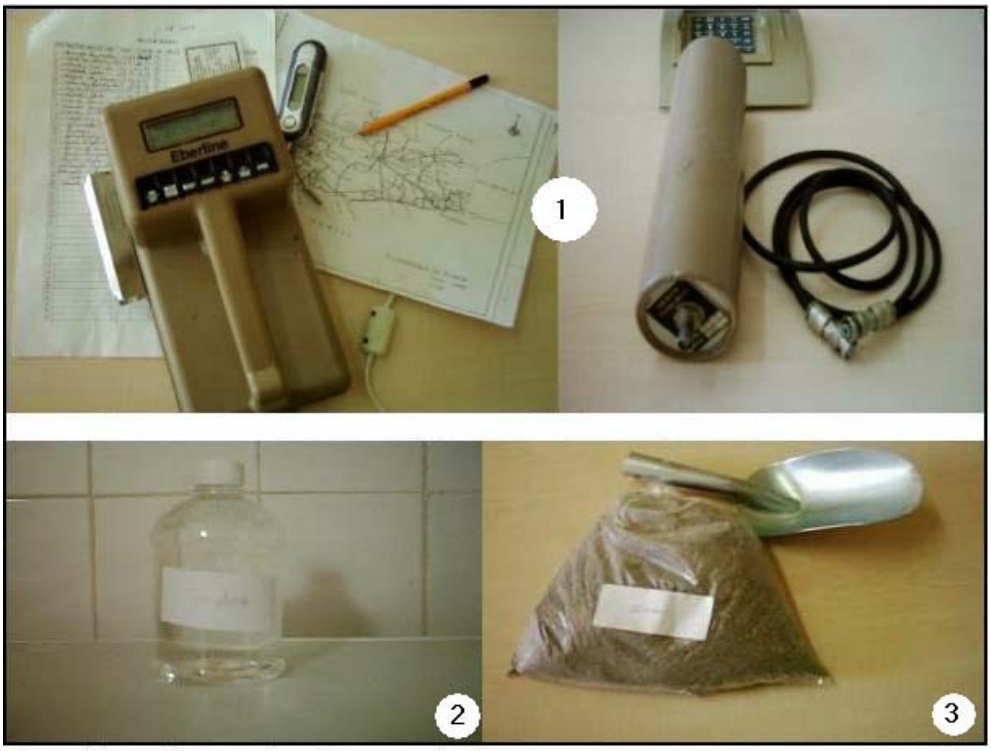

Figure 1. Study supplies and samples
(Şekil 1. Çalışma araçları ve örnekler)

1- Gamma exposure dose rates were measured by Eberline smart portable device ESP-2, connected with a SPA-6 model plastic detector.
2- Gross alpha and beta counting of the main drinking water samples taken from municipal supplies and its were performed by using proportional counter with gas-flow (Berthold, LB77-PC 10).
3- Soil samples, collected from different points in the area were analyzed by using a gamma-ray spectrometry system, connected with an HPGe detector and the radioactivity concentrations of the elements of uranium and thorium

Investigated area is terrestrial area of Edremit Gulf's a center city located in the northeast of Aegean Sea, next to Midilli was chosen for measuring site, shown in Fig.2. Environmental sampling was performed at many places in the border of the city.

Figure 2. Map of study location
(Şekil 2. Çalışma alanın yer bulduru haritası)

4. FINDINGS (BULGULAR)

Gamma exposure dose rates measurements: Gamma exposure dose rates were measured by Eberline smart portable device, ESP-2, connected with a SPA-6 model plastic scintillation detector. Results were obtained as mR h-1 and transferred to absorbed dose, nGy h-1. Outdoor rates in air measured at 16 points are ranging from 38.0 nGy to 165 nGy h-1 with an arithmetical mean of 492 ± 4 nGy h-1. Indoor gamma exposure dose measurements were performed in dwellings located in Edremit city center, in Table 1.

Annual effective doses caused by gamma exposure were calculated according to the model given in report (Anonymous 2). In that model, the conversion coefficient from absorbed dose to effective dose in air is 0.7 Sv Gy-1; the occupancy factor for indoor and outdoor gamma exposure is 0.8 and 0.2, respectively.

Tablo 1. Gamma exposure dose nGy h-1
(Tablo 1. Gama ışıma dozları nGy h-1)

Location	Result
Balıkesir Province Border	11.10
Edremit Front of Tariş	5.54
Mosque of Gümrük Serati	7.00
Edremit Çayiçi	7.31
Edremit Public Square	7.47
Edremit Way of Hospital	10.33
Edremit Park	6.46
Edremit Garage	6.68
Altınoluk	4.78
Akçay	4.58
Yeşilyurt	14.50
Küçükkuyu Beach	5.78
Küçükkuyu Electricity Transformer	6.50
Küçükkuyu Tariş	8.14
Sakallı Süleyman Efendi	6.85
Sea Surface	1.80

Radioactivity Measurements in water resources: Gross alpha and beta counting of water samples were performed by using a proportional counter with gas-flow (Berthold, LB770-PC 10), commonly used in measuring the environmental samples with low natural background radiation (Tsoulfanidis 1983). Water samples of 500 cm^3 in volume were taken from municipal supplies, wells, and fountains located in the different places of the region and evaporated at a temperature under boiling point until to 100-110 cm^3, then poured into the stainless steel vessels of 20 cm^3 in volume. The vessels were heated until to obtain residue and in each vessel was weighted. The amount of the residue in vessels should be lower than 400 mg. For alphas counting is being constant for over 400 mg because of self-absorption. For beta counting, because of the self-absorption, the amount of the residue should not be higher than 2000 mg. Gross alpha and beta activities of the water samples were tabulated in Table 2.

Table 2. Radon concentrations of water around Edremit Gulf concentrations (Bq/m^3)
(Tablo 2. Edremit Körfezi çevresinde Radon su konsantrasyonları (Bq/m^3))

Location	Result	
Edremit	0.0244±0.0235	0.0719±0.0051
Akçay	0.0179±0.0028	0.0797±0.0035
Altınoluk	0.0221±0.0039	0.0565±0.0051
Küçükkuyu	0.2960±0.0073	0.1990±0.0057

Natural radioisotope concentrations in soils: Soil samples were collected from different points of the region. Sampling was made in the areas of non-agricultural and non-destroyed by flood. Soil samples were cleaned from any material, dried, grinded and sieved. Using by Marinelli beaker, they were weighted, then tightly closed for air leakage and stored for 1 month in order to allow a secular equilibrium between ^{226}Ra, ^{222}Rn decay. Then, soil samples were analyzed by using a gamma spectrometry connected with an HPGe detector and the activity concentrations were tabulated in Table 3.

Table 3. Natural radioisotope concentrations of soil samples collected from Edremit Gulf area (Bq/kg)
(Tablo 2. Edremit Körfezi çevresinde toplanan toprak örneklerinin Radyoizotop konsantrasyonları (Bq/kg)

Location	**^{226} Ra**	**^{214}Pb**	**^{232} Th**	**^{214} Bi**	**^{228} Ac**	**^{40} K**
Edremit	82 ±4.59	52 ±1.45	93 ±2.13	46 ±1.33	87 ±2.52	872 ±13.9
Akçay	78 ±1.87	63 ±0.50	67 ±0.80	58 ±0.58	65 ±0.97	844 ±5.9
Altınoluk	64 ±2.81	76 ±0.98	35 ±1.01	67 ±1.07	30 ±1.23	391 ±7.0
Küçükkuyu	81 ±3.72	59 ±1.06	94 ±1.69	61 ±1.15	85 ±2.12	842 ±11.78

5. DISCUSSION (TARTIŞMA)

Chernobyl reactor's graphite core, which started to burn, discharging noble gases, fission products, and uranium fuel into the atmosphere (Savchenko, 1995). The casualty has been estimated that the total release amounted to around 2×10^{18} Bq of condensable fission and transuranium activation products, 6.7×10^{17} Bq of radioiodine, 1.9×10^{16} Bq ^{134}Cs and 3.7×10^{16} Bq ^{137}Cs (Appleby and Luttrell, 1993). Larger particles (>10 μm) were deposited close to the location of the accident, with 0.3–0.5% being on site and 1.5–2.0% within 20 km. Not only this area, also smaller particles was deposited further a field, from a plume which traveled round the Northern Hemisphere (Appleby and Luttrell, 1993). The study area possible affected by Chernobyl reactor's exhaled radioactive emissions.

World Health Organization, WHO advises 0.1 Bq/l for gross alpha and 1.0 Bq/l for gross beta activity as limit values for drinking water (Anonymous 4). These limits are also accepted by Turkish Standardization Institute (Anonymous 5). As seen in Table 1, gross beta activities of all water samples collected from the region are considerably under the reference value of 1.0 Bq/l. Gross alpha activities are also significantly lower than given the limit. They are originally surface waters and are taught to be contaminated by artificial fertilizer used in agriculture. Generally speaking, water samples investigated here are in potable quality from the radiological safety point of view.

In soil samples activity concentrations of ^{226}Ra, ^{214}Pb, ^{214}Bi, the decay products of ^{238}U chain and ^{228}Ac and the decay products of ^{232}Th chain, ^{40}K were determined (Table 3).

The average value for ^{226}Ra in Gulf Shores soil was found as 36.501 Bq/kg with a range between 1.87-82 Bq/kg. Minimum values content in Altınoluk, maximum values content in Edremit. Values of Altınoluk, Edremit and Küçükkuyu are a few times higher than the mean ^{226}Ra of Edremit Gulf Area, as seen in table. Those of others are changing around or lower than the average. The results of the spectrometric analyses of soil samples gathered in different countries are given at Table 3. The national mean value for ^{226}Ra is oscillations are between 1.87-82 Bq/kg, with a world-wide median value of 35 Bq/kg. The inference value of Edremit Gulf Shores is comparable with it, but the place mentioned above has higher ^{226}Ra than the worldwide median value (Anonymous 6).

Radioactivity distributions of ^{214}Pb, and ^{214}Bi of Edremit Gulf's terrestrial area soil are shown and the averages are respectively to each other. Average value is 31.113 Bq/kg, for ^{214}Pb and also ^{214}Bi 28.909 Bq/kg. Highest radioactivity concentrations were also reached in the same places, above-mentioned.

The same similarity can also be established in activity distributions of ^{228}Ac and ^{208}Th. The averages of them are obtained as 43.08 Bq/kg (^{228}Ac) and 35.873 Bq/kg (^{232}Th).

In soil studies, the average of the concentrations of the decay products is frequently used for the radioactivity concentration of the main radio nuclide of the decay chain. As a conclude, ^{238}U concentration, as the arithmetic mean of ^{226}Ra, ^{214}Pb, ^{214}Bi, was calculated as 28.91 Bq/kg and ^{232}Th concentration, as the arithmetic mean of ^{228}Ac and ^{208}Th, was calculated as 38.83 Bq/kg. In this case, the average concentration of ^{232}Th in Edremit Gulf Shores soil is higher than that of ^{238}U. But, the concentration ^{of} ^{238}U in terrestrial area of Edremit Gulf's soil is lower, and ^{232}Th concentration is higher than the worldwide median values (Anonymous 6).

The natural radionuclide concentration of ^{40}K in soil was found as 363.802 Bq/kg with a range between 5.9-872 Bq/kg. The worldwide median value is ^{400} Bq/kg with a range between 140-850 Bq/kg. The natural radionuclide concentration of ^{40}K in terrestrial area of Edremit Gulf soil is greater than that of the worldwide national surveyed values, a few times higher in some locations. The highest values were obtained in northern part ^{40}K radioactivity map of terrestrial area of Edremit Gulf.

It is an absolutely classic example of the limit of taking a narrow view of Edremit environmental matters. There is little doubt that with a more experimental approach the confident cheerful predictions of the future significance of any radioactiv deposition for the Edremit Gulf terrestrial area would not have been made. The lesson is that a full understanding of the geographical features of

contaminants can only be developed by a strong ecological approach to pollution problems.

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