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Measurement Of Natural And ^{137}Cs Radioactivity Concentrations At Izmit Bay (Marmara Sea), Turkey

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Abstract. In order to determine the radioactivity level at Izmit Bay Marmara Sea, marine sediment samples were collected from five different locations. The radioactivity concentrations of naturally occurring ^{238}U, ^{232}Th and ^{40}K isotopes and also that of an artificial isotope ^{137}Cs were measured by using gamma-ray spectroscopy. Preliminary results show that the radioactivity concentrations of ^{238}U and ^{232}Th isotopes are lower than the average worldwide values while the radioactivity concentrations of the ^{40}K are higher than the average worldwide value. A small amount of ^{137}Cs contamination, which might be caused by the Chernobyl accident, was also detected.

INTRODUCTION

The most contribution to the natural radioactivity are from naturally occurring isotopes of ^{232}Th, ^{238}U, ^{235}U and ^{40}K, which are left over from the creation of the earth and found in the earth's crust [1]. The first three of them are called the natural decay series, and their members down to one of the stable isotopes of the lead are also radioactive. However, ^{137}Cs is a man-made radioisotope, released by nuclear weapon trails or nuclear power plant accidents, and its presence builds up radiation level in the nature [2]. It is well known that Turkey was widely effected the Chernobyl nuclear power plant disaster. Over several days after the accident, northern part of the Turkey including Marmara region was contaminated with the radioactivity [3].

All living organism reside in a ubiquitous radiation in the nature. A marine ecosystem is a living area for various organisms and these organisms may subject to radiation emitted from seabed sediments. Therefore, some radionuclides might indirectly enter the human food chain. Among these radionuclides, since they are natural, heavy metals such as U and Th are of significant importance for human health [4].

The main objective of this study is to determine radioactivity concentrations of eastern basin of Izmit Bay Marmara Sea. Beside this, the results may be used as a reference in any circumstances which may cause radioactive contamination such as a nuclear disaster or an earthquake which take place in the vicinity of the region in question [2].

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MATERIALS AND METHODS

Sample Preparation

The sediment samples were collected by Ekman-type grab sampler in the late November in 2014, in the locations as shown in Figure 1. Each one of five samples was dried at 40 °C in an oven in order to get constant weight, and then properly sieved to eliminate relatively big grains. Each sample was homogenized and transferred to the 170 mL plastic container. The containers were weighted with and without sediments in order to determine net mass of the samples. The samples were sealed and left in rest for one month in order to set the secular equilibrium of ^{238}U, ^{232}Th isotopes with their progenies.

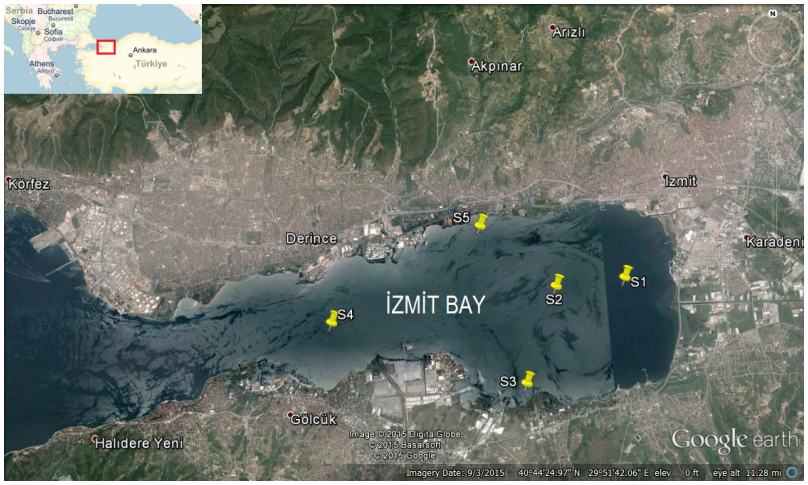


FIGURE 1. Sampling locations at İzmit Bay

Measurements and Analysis

The sediment samples, collected from the eastern basin of Izmit Bay Marmara Sea (Figure 1), were counted by using hyper pure germanium (HPGe) gamma ray spectrometry consisting of p-type intrinsic germanium coaxial detector with the relative efficiency of 25 %, and an Ortec DSPEC jr 2.0 which incorporates all necessary electronics. The data acquisition and analysis of the spectra were carried out with Ortec GammaVision-32 software. In order to reducing background radiation effect, the detector was shielded with 10 cm lead and internally lined with 1 mm thick Sn and 1.5 mm thick Cu. The counting geometry for the each sample was same as that of the standard radionuclide source used for determining the energy-dependent efficiency of the detector. The standard mix radionuclide source is 170 mL high density solid in a 0.2 L plastic jar, and it contains ^{241}Am, ^{109}Cd, ^{57}Co, ^{139}Ce, ^{203}Hg, ^{113}Sn, ^{134}Cs, ^{137}Cs, ^{54}Mn, ^{88}Y and ^{65}Zn.

The radioactivity concentrations of ^{238}U were calculated by analyzing gamma transitions of ^{214}Pb (609.32 keV, 1120.294 keV and 1764.491 keV) and ^{214}Bi (295.22 keV and 351.93 keV); for ^{232}Th activities, ^{212}Pb (238.632 keV) and ^{208}Tl (583.187 keV and 2614.511 keV) were analyzed. The 1460.82 keV and 661.66 keV gamma rays were used to determine the radioactivity concentrations of ^{40}K and ^{137}Cs, respectively. The samples were counted in a time range from 95000 s to 170000 s in order to get sufficient statistics.

RESULTS AND DISCUSSION

The gamma transitions, in each of the series, given in the previous section were used to give the weighted average values of the activity concentrations of ^{232}Th and ^{238}U. Preliminary results for the radioactivity concentrations of naturally occurring isotopes ^{238}U , ^{232}Th and ^{40}K and also man-made isotope ^{137}Cs in the samples are presented in Table 1. All results are expressed as Bq/kg dry weight. The radioactivity concentrations of the samples ranged from 9.30 ± 0.29 to 16.37 ± 0.49 Bq/kg, 15.56 ± 0.24 to 24.66 ± 0.37 Bq/kg, 403.05 ± 12.91 to 614.27 ± 19.81 Bq/kg,

TABLE 1. Radioactivity concentrations of ^{238}U, ^{232}Th, ^{40}K and ^{137}Cs in Bq/kg for sediments.

Sample	^{238}U	^{232}Th	^{40}K	^{137}Cs
S1	12.46 ± 0.38	18.16 ± 0.25	502.59 ± 15.93	29.31 ± 0.92
S2	12.68 ± 0.48	24.66 ± 0.37	576.90 ± 19.42	32.45 ± 1.11
S3	9.30 ± 0.29	15.56 ± 0.24	403.05 ± 12.91	5.87 ± 0.26
S4	16.09 ± 0.51	22.64 ± 0.32	614.27 ± 19.81	9.01 ± 0.40
S5	16.37 ± 0.49	22.82 ± 0.33	548.35 ± 17.54	33.15 ± 1.04

5.87 ± 0.26 to 33.15 ± 1.04 Bq/kg for ^{238}U , ^{232}Th, ^{40}K and ^{137}Cs, respectively. The radioactivity concentrations of ^{232}Th, ^{238}U isotopes were found lower than the average worldwide values while those of ^{40}K was found higher than the average worldwide value [5]. Sample 1, 2 and 5 have higher radioactivity concentration of ^{137}Cs compared to the other two samples.

CONCLUSION

The radioactivity concentrations of ^{238}U, ^{232}Th and ^{40}K which are the main contributors to the natural radiation level and that of man-made ^{137}Cs were determined by using a HPGe detector. Since ^{40}K is more abundant than ^{238}U and ^{232}Th in the earths' crust, the radioactivity concentration of ^{40}K is higher than those of ^{238}U and ^{232}Th. In all samples, ^{238}U and ^{232}Th radioactivity concentrations are lower than the average worldwide values which are 35 bq/kg and 30 bq/kg, respectively while radioactivity concentration of ^{40}K is higher than average worldwide value of 400 bq/kg in all samples [5]. The Chernobyl nuclear power plant disaster may cause presence of the ^{137}Cs, and its radioactivity concentrations are higher in the samples (S1, S2, S5) collected from the industrialized part of the bay. Similar conclusions were also reported in former study at around our sampling location [6].

The marine water samples were also collected from different depths at the same sampling location are under analysis. After finishing the analysis of these data, the results and further conclusion will be published in an other article. The results of this work can be used as a baseline in Izmit Bay for assessing any possible change in the future because of the external factors.

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