

Natural Radioactivity Levels on Surface Water of Nemrut Crater Lake (Bitlis, Turkey)

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Nemrut Crater lake is the world's second largest and largest of Turkey crater lake and its altitude is 2250 m. The aim of this study is to determine radioactivity levels of the lake surface water. In this study water samples were collected from 33 points of the lake surface. The gross alpha and gross beta activity concentrations were determined by using ultra low level α/β counter. The mean gross alpha and beta activity concentrations were found to be 77.69 mBqL^{-1} and 115.36 mBqL^{-1} respectively. Contour maps were produced for gross alpha and beta concentrations of the lake.

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1. Introduction

Determination of natural radioactivity has become an important parameter in environmental research. The natural radioactivity is originated with radioisotopes of natural decay chains in earth, cosmic radiations and man-made artificial radiation sources. Generally radioisotope contents in water and soil are determined in environmental research. Natural waters are known to contain both alpha (e.g., ^{238}U) and beta (e.g., ^{40}K) emitters in a wide range of concentrations. Generally, they are responsible for a small fraction of the total dose received from natural and artificial radioactivity [1]. Natural waters contain both α (e.g., ^{238}U) and β (e.g., ^{40}K) emitters in widely varying concentrations which are responsible for a generally small fraction of the total dose received from natural and artificial radioactivity [2].

Alpha activity is mostly due to uranium isotopes (^{234}U , ^{235}U and ^{238}U) and to ^{226}Ra [3]. Beta activity is usually due to a large extent to ^{40}K and to short-lived daughters of ^{238}U , ^{234}Th and ^{234}Pa [4].

There are lots of studies about natural radioactivity in water, soil and sediment samples in the literature. In these studies water samples are collected from sea, lake, river, spring water or tap water for radioactive analysis. Radioactivity level determinations of lake waters have been made many lakes of our country. But only Akyl S. et al. (2009) have made a study about radioactivity level determination on a crater lake in Turkey. Nemrut Crater lake is second largest crater lake of the World and largest one of Turkey. Aim of this study to determine of radioactivity levels on surface water of the lake and to present of radioactivity distribution of the lake surface with contour maps.

2. Experimental

2.1. Site description

Van lake is located in eastern Turkey and largest lake of there. Nemrut Crater lake is located in 15.6 km west side of Van lake and it is a dormant volcano lake. Altitude of the lake surface is 2250 m, maximum depth is 176 m and lies at $42^{\circ}12'00''$ – $42^{\circ}15'00''$ E longitudes and $38^{\circ}36'00''$ – $38^{\circ}38'40''$ N latitudes. The average annual rainfall in this area where in the province of Bitlis/Turkey was determined to be about 1230 mm (Meteorological Service of Turkey — www.mgm.gov.tr).

2.2. Sampling process

A zodiac bot was used for the surface water sample collection on Nemrut Crater lake. Surface water samples were collected from 33 point of the lake surface in August 2013. Coordinates of the sample collection points were determined by Global Positioning System (Magellan Triton 400) and illustrated on Fig. 1. 1.5 L sample was collected from each point by using 0.5 and 1 L polypropylene sample bottles which were carefully cleaned in the laboratory before sampling. The samples were collected about 20 cm below surface of the lake and 3 N nitric acid added it. In this way pH value drops below 2 and then biological assets, precipitation and adsorption of contents of water sample on container walls are prevented [5].

For gross alpha and beta analyze each water sample were evaporated without boiling at 70°C temperature in 600 ml volume. The residue in the vessel was scraped and placed on a planchette with 5.1 cm diameter [6].

2.3. Gross Alpha and Beta measurements

The measurements of gross alpha and beta activity concentration in the samples were made by ultra-low level α/β counter MPC 9604-1 (Protean Instrument Corporation). The sample detectors are pancake style gas flow proportional type and lead shielding thick is 10.2 cm. The counting gas was a mixture of 90% argon and

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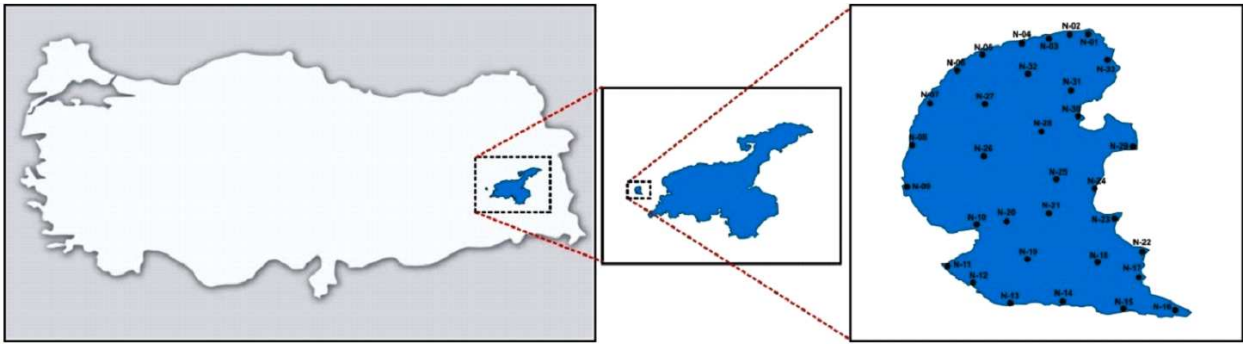


Fig. 1. Location of Nemrut Crater lake in Turkey and sampling points on the lake surface.

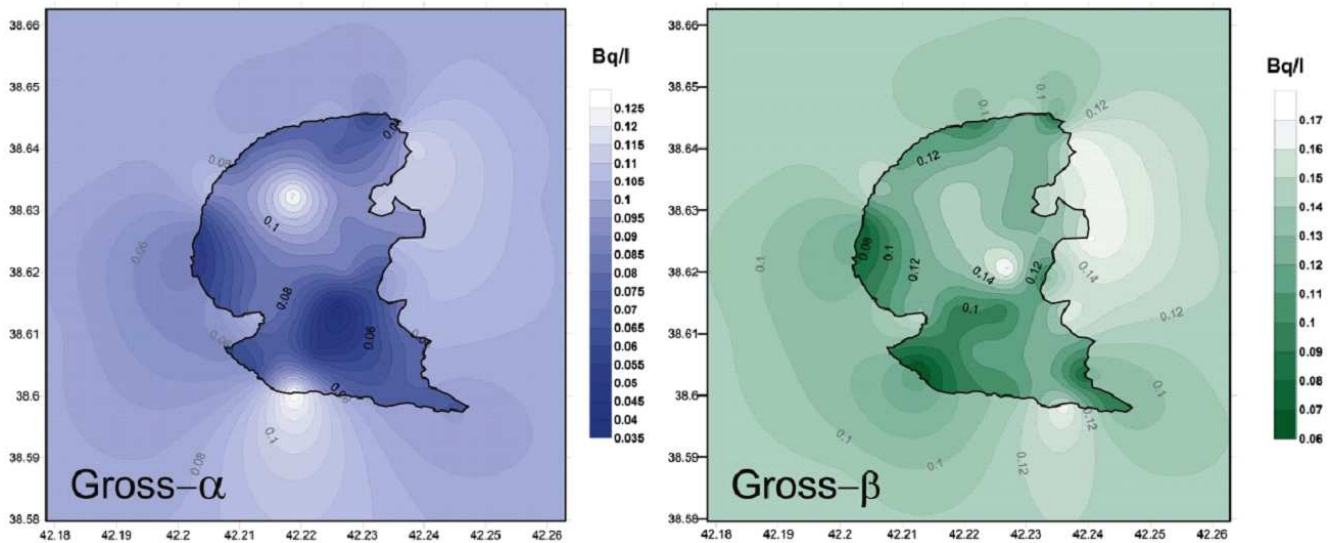


Fig. 2. Contour maps of gross alpha and gross beta activities of the Nemrut Crater lake.

10% methane (P-10). The bias voltage of the detectors was adjusted to 1515 V. The detectors were calibrated for α and β energies using by ^{241}Am (185 Bq) and ^{90}Sr (172 Bq) standard sources respectively. Backgrounds of each detector were determined by counting empty planchets for 720 m. Sample count was made 600 m. intervals for each samples.

3. Results and discussion

The contour maps were drawn for gross alpha and gross beta activities (Fig. 2) by using the Kriging method. According to obtained results, the minimum value for gross alpha activity is 36 BqL^{-1} at point 21 and maximum one is 128 BqL^{-1} at point 21. Mean gross alpha activity value is 77.697 BqL^{-1} and. The minimum value for gross beta activity is 58 BqL^{-1} at point 12 and maximum one is 176 BqL^{-1} at point 25. Mean gross beta activity value is 115.364 BqL^{-1} . Mean gross alpha value of the lake is bigger than gross alpha of Van lake and vice versa for gross beta.

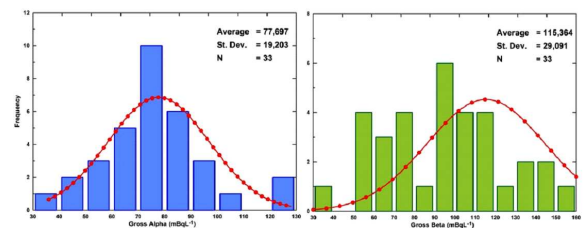


Fig. 3. Frequency distributions of gross alpha and gross beta activities of the Nemrut Crater lake.

Frequency distribution functions observed for gross alpha and gross beta with calculation of skewness and kurtosis coefficients (Fig. 3). When the skewness is positive value, the distribution is asymmetric and skewed left side. If it is negative, the distribution asymmetric and skewed right side. Positive kurtosis indicates a relatively peaked distribution. Negative kurtosis indicates a relatively flat distribution. Skewness and kurtosis values calculated as 0.55 and 3.97 for gross alpha and 0.11 and 2.20 for gross beta.

TABLE

Average activity concentrations for gross α and β of different lakes in Turkey.

lake	gross- α [mBqL ⁻¹]	gross- β [mBqL ⁻¹]	references
Hazar	1190	80	[7]
Keban Dam	60.5	55	[8]
Karagol	30	2620	[9]
Golcuk	750	2350	[9]
Cakalbogaz	30	1770	[9]
Seyhan	12	42.6	[10]
Van	9	912	[11]
Bolu	71.28	127.64	[12]
Nemrut Crater	77.69	115.36	present study

4. Conclusions

The main objective of this study is to provide background information about natural radioactivity for scientific research which will be done in this region. Gross alpha and gross beta concentrations were determined at Nemrut Crater lake and highest values of these concentrations were observed on deepest region of the lake. In order to obtain more detail information about the crater lakes, radioactivity levels and chemical compositions must be determined in soil and sediment in the caldera of the lake.

This study is one of the radiological researches on the crater lakes and this type researches must be continued because there are no many studies about crater lakes in literature.

Acknowledgments

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