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Determination of Natural Radioactivity from ^{232}Th with Gamma-Ray Spectrometer in Dereköy-Yazır (Southwestern Anatolia)

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This study presents new data on the baseline concentrations of Thorium over the Dereköy-Yazır (Ağlasun-Burdur) volcanic area. Portable gamma-ray spectrometer was used for natural thorium mapping. In situ measurements were made in the field, in the area of 7.5 km² at 165 points. Variations in the Th concentration in the surficial environment of the Dereköy-Yazır region appear to be related to bedrock lithology. The measured thorium concentration varies between 0.68–36 ppm, in the studied area. The highest concentration values were obtained from volcanic rocks. The outcropping volcanic rocks in the region are Pliocene alkaline basalts.

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1. Introduction

There are over 20 naturally occurring radioactive elements, however the terrestrial radiation is dominated by the emission products from just three elements: potassium (K), uranium (U) and thorium (Th). The radiometric method measures naturally occurring radioactivity in the form of gamma-rays [1–3]. Most of this radiation originates from mineral species, containing radioactive isotopes of three elements (^{40}K , ^{238}U , ^{232}Th). Gamma ray spectrometry (GRS) is a passive geophysical method. Radiometric surveys for mineral exploration or lithological mapping are routinely made from the air and on the ground. Ground radiometric surveys are usually conducted with hand-held gamma ray spectrometers.

2. Materials and method

2.1. Gamma-ray spectrometry

In this study, measurements were made with gamma-ray spectrometer (Gf Instruments, 1024 channel) at 165 observation point. Measurements were taken for 180 seconds at each point. At the same time the coordinates were also recorded using GPS.

In the gamma spectrometry measurements, an equivalent thorium (eTh) value is determined from the 2.62 MeV ^{208}Tl gamma peak. Therefore adequate gamma peaks cannot be recorded directly from ^{232}Th themselves and are described by the equivalent thorium (eTh).

2.2. Brief geology and geochemistry

The studied area was in the Ağlasun graben, which due to its geological, lithological and geomorphological characteristics, is representative of the Isparta Angle and covers a small part of Gölcük volcanic area [4, 5]. This studied area which is composed of Bey Dağları carbonate massif, Eocene limestones, alluvium, Eocene and Paleocene carbonates and (stated as 4.07 million years old by Lefevre [6]) volcanic rocks (Fig. 1). These volcanic rocks, that outcrop near Dereköy-Yazır, have basaltic character and are cutting through the Eocene carbonate sediments. These are the Pliocene volcanic rocks.

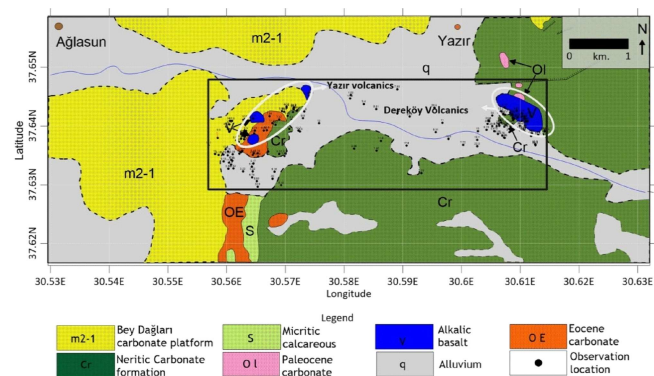


Fig. 1. General geology map of studied area.

These volcanic rocks, according to the classification of potassic rocks, have been classified as having shoshonitic and alkaline character.

2.3. Mapping of ^{232}Th concentration and assessment

The activities of naturally occurring radionuclide were measured and mapped at 165 locations by in situ measurements of ^{232}Th , using gamma-ray spectrometry

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(Fig. 2). Activity concentration of ^{232}Th has ranged from 0.68 to 36 ppm. The highest elemental concentrations of thorium are exhibited by the Dereköy and Yazır volcanic rocks, with values reaching levels of 27 to 36 ppm, respectively. Radiometric values and values of geochemical analysis show very similar patterns (Table). The lowest concentrations of thorium, ranging from 2 to 9 ppm, are exhibited by limestone. In general, concentrations of ^{232}Th in volcanic rocks are higher than in sedimentary rocks, such as limestone and chalk.

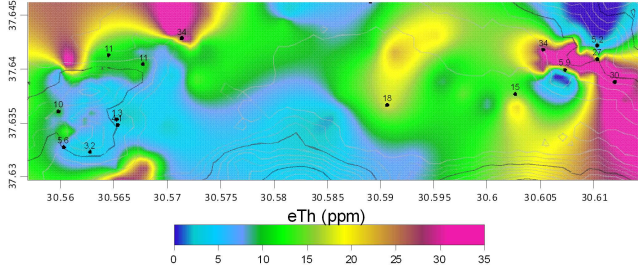


Fig. 2. Equivalent thorium (eTh) map of studied area.

TABLE

Geochemical parameters of Dereköy-Yazır volcanic rocks [7].

Parameter	Value range
SiO ₂ [%]	57.43–58.09
K ₂ O [%]	3.18–3.51
Th [ppm]	24.20–33.30

3. Conclusions

The results obtained by gamma spectrometry (eTh) and geochemical analysis (Th) correlate significantly for regional volcanic rocks.

Volcanic rocks associated with alkaline basalts have the highest concentration of eTh in the observed area. A lower concentration was found in alluvium, limestone and chalk. This contrast is so clear, that the field radiometric surveying has become a useful tool for geologic mapping and determining different lithological units.

Acknowledgments

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