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Soil gas radon concentrations measurements in terms of great soil groups

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ABSTRACT

In this study, soil gas radon concentrations were investigated according to locations, horizontal soil layers and great soil groups around Tuzla Fault, Seferihisar-İzmir. Great soil groups are a category that described the horizontal soil layers under soil classification system and distributions of radon concentration in the great soil groups are firstly determined by the present study. According to the obtained results, it has been showed that the radon concentrations in the Koluvial soil group are higher than the other soil groups in the region. Also significant differences on location in same great soil group were determined. The radon concentrations in the Koluvial soil groups were measured with respect to soil layers structures (A, B, C1, and C2). It has been observed that the values increase with depth of soil (C2>C1>B>A). The main reason may be due to the meteorological factors that have limited effect on radon escape from deep layers. Although fault lines pass thought the study area radon concentrations were varied location to location, layer to layer and great group to great group. The study shows that a detailed location description should be performed before soil radon measurements for earthquake predictions.

1. Introduction

Radon (^{222}Rn) can be migrating effectively from Earth crust to atmosphere by diffusion and by convective flow (Kristiansson and Malmqvist, 1982; Etiope and Martinelli, 2002; Zmazek et al., 2006; Sundal et al., 2008). The transport of radon in the ground is affected by phenomena accompanying seismic events (Scholz et al, 1973; King, 1978; Ui et al., 1988; Ohno and Wakita, 1996; Pulinets et al., 1997; Toutain and Baubron, 1999; Planinic et al., 2000; Belyaev, 2001; Virk and Walia, 2001). When monitoring of the radon variations shortly before or during an earthquake, an anomaly in radon level may be observed (Zmazek et al., 2006). Radon has been monitored in different geological media such as shallow soil, solid rocks, alluvial deposits, caves, tunnels and mines during the last 40 years. The major aims of the recent studies were to determine the relationship between radon concentration changes and the potential risk of radon in increasing lung cancer, or the relationship with geophysics, tectonic events including earthquakes and volcanic eruptions (Zafrir et al., 2011).

There are many different factors that affect the radon escape from soil to atmosphere. These are meteorological factors (atmospheric pressure, temperature, and humidity), geological structure, soil characteristics and location etc. (de Jong et al., 1994; Swakon et al., 2005; Vaupotic et al., 2007). In spite of many detailed investigations on meteorological factors and geological structure, only a few of study have focused on soil characteristics. Vaupotic et al. (2007) investigated radon and radioactivity potential of "terra rossa" soil in Croatian Krastic Region and they have indicated that radon activity levels in soil gas differ from point to point. In another study conducted in 2001 by Jönsson, soil depth relation was investigated regardless of horizontal soil layers and soil structure. As a starting point, we examined radon concentrations in the great soil groups with respect to soil layer structures. Great soil groups are a category that described the horizontal soil layers under soil classification. All over the world totally 230 great soil groups defined. In soil classification system six hierarchic categories are order, suborder, great soil groups (great group), subgroup and family (İçhedef, 2011).

Tuzla fault is the one of the most important faults around İzmir City which is the third biggest city of Turkey. An earthquake (Mw = 6.0) occurred on Doğanbey promontory is well recognized by the character of this fault (Ocakoğlu et al., 2005). Strike-slip

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faults crossing the Anatolia have great lengths longer than 50 km; however, the fault lines continue under the sea of Aegean (Aktuğ and Kılıçoğlu, 2006). The fault is also located on reach area in terms of thermal springs. Hot water springs are located at or near the fault intersections and the main springs are Doğanbey, Tuzla, Karakoç, and Cumalı hot springs (Fig. 1) and the area named as Seferihisar Geothermal Field (Vengosh et al., 2002; Drahor and Berge, 2006).

Our surveys were focused on soil gas radon concentrations according to location, soil layer and great soil groups around Tuzla Fault, Seferihisar-İzmir. The study was performed over an area of approximately 40 km^2 (4 km × 10 km). In this paper we present the results of periodic radon measurements performed using LR-115 Type 2 detectors.

2. Material and methods

2.1. Study area

The Aegean Region is located along the Western Anatolia. Eastern part of Aegean Region has large E–W and some NE–SW striking grabens. Seferihisar geothermal area is located in the Çubukludağ Graben composed of the Paleozoic crystalline schist's of the Menderes massif, which outcrop in a large area to the southeast. The main faults bounding the Çubukludağ Graben strike generally NE–SW and younger NW–SE and W–E faults are also present. Hot water springs (Doğanbey, Tuzla, Karakoç, and Cumalı) are located at or near the fault intersections (Drahor and Berge, 2006). Since the early 1970s, lots of wells have been drilled in this area, but only three wells are presently available. They are of moderate depths (150–350 m) and have temperatures in the 120–153 °C range (Serpen et al., 2009).

Study area is covered by five great groups have been described as Alluvial (Typic Xerofluvent), Koluvial (Typic Xerorthent), Non Calcic Brown (Typic Haploxeralf), Non Calcic Brown Forest (Typic Argixeroll) and Brown Forest (Typic Xerochrept) according to Soil Taxonomy (Table 1).

Table 1
Detail list of measurement stations.

Station ID	Coordinates	Location (vegetation)	Great group-(symbol)-Latin name
I-1	38 07 621 N 26 54 658 E	Cumalı (Olive Garden)	Non Calcic Brown (U) Typic Haploxeralf
I-2	38 07 523 N 26 54 727 E	Cumalı (Garden)	Koluvial (K) Typic Xerorthent
I-3	38 04 288 N 26 54 542 E	Doğanbey Road (Grassland)	Alluviyal (A) Typic Xerofluvent
I-4	38 06 324 N 26 54 990 E	Karakoç Road (Grassland)	Non Calcic Brown (U) Typic Haploxeralf
I-5	38 04 999 N 26 55 469 E	Karakoç (Tangerine Garden)	Alluviyal (A) Typic Xerofluvent
I-6	38 04 643 N 26 54 455 E	Doğanbey Road (Wheat)	Koluvial (K) Typic Xerorthent
I-7	38 05 940 N 26 54 231 E	Tuzla (Olive Garden-Grassland)	Non Calcic Brown Forest (N) Typic Argixeroll
I-8	38 06 053 N 26 54 110 E	Tuzla (Forest)	Brown Forest (M) Typic Xerochrept
I-9	38 07 693 N 26 54 998 E	Cumalı (Forest)	Brown Forest (M) Typic Xerochrept
I-10	38 05 347 N 26 55 177 E	Karakoç (Forest)	Non Calcic Brown Forest (N) Typic Argixeroll

2.2. Techniques

It was selected 10 measurement fields from 5 great groups for soil gas radon measurements. In each measurement field, soil was excavated as cylindrical hole until the geologic material and then horizontal soil layers have been defined (Fig. 2). A PVC pipe was installed in each hole. Detectors were attached to a plastic cup, which serves as a thermal isolator to minimize water vapor. The cup was turned upside down in to the base of PVC pipe (Vulkan et al., 1992; Papastefanou, 2007). A schematic description of this system is illustrated in Fig. 3.

After completed the installation of the each station, measurements were started. The station 5 (I-5) was failed because of flooding. Soil gas radon measurements were carried out

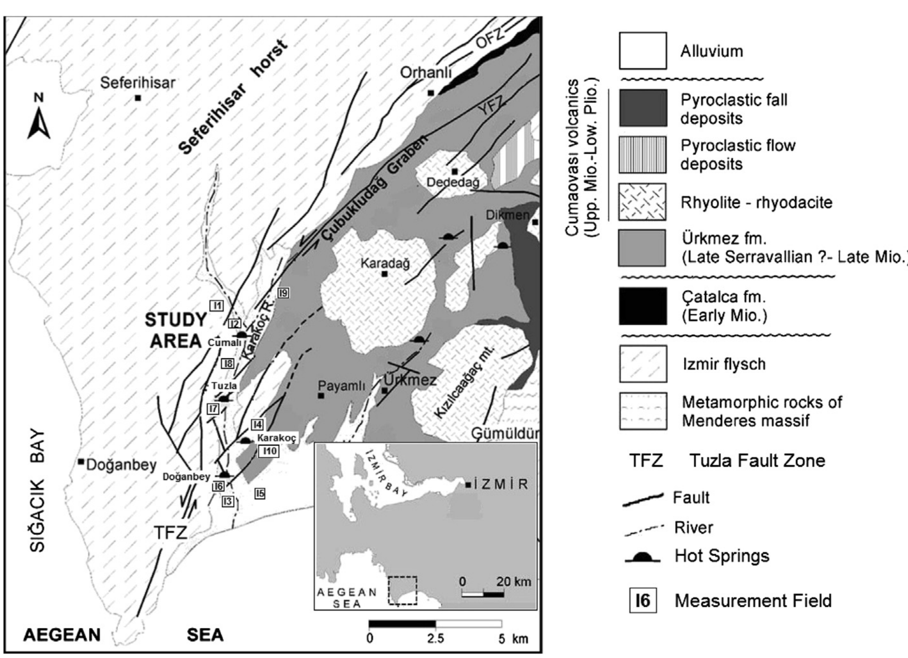

Fig. 1. Detailed geological map of study area (compiled from Drahor and Berge, 2006).