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Short communication

Measurements of radon concentrations in well waters near the Akşehir fault zone in Afyonkarahisar, Turkey

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Abstract

Afyonkarahisar is located in the mid-west Anatolia in Turkey where Akşehir fault zone lies. This earthquake active zone has produced earthquakes in magnitudes from 3.0 to 7.1 in Richter scale. The ^{222}Rn concentrations in well waters near the fault zone in Afyonkarahisar and its surroundings were determined for the first time. Samples were studied with a Packard Tri-Carb 2770TR/SL model liquid scintillation analyzer. The measured values ranged from 0.7 to 31.7 Bq/L.

Keywords: Well water; Radon concentration; Seismicity; Liquid scintillation analyzer; Afyonkarahisar

1. Introduction

"Radon is a radioactive nuclide with a half life of 3.82 days, which is a chemically inert gas and highly soluble in water. It is produced continuously in rocks and minerals through α-decay of ^{226}Ra" (Baykara and Doğru, 2006). Its decay products emit particles (5.49, 6.00 and 7.69 MeV). Using a Packard Tri-Carb 2770TR/SL liquid scintillation analyzer (LSA), it is possible to view the alpha spectrum as follows. The peaks of radon-222 (5.49 MeV), polonium-218 (6.00 MeV) and polonium-214 (7.69 MeV) can be distinguished.

The radon concentration in groundwater is proportional to uranium concentration in adjacent rocks and soil in an aquifer, hydrothermal solution (in which hot water serves as a concentrating, transporting, and depositing agent) and with variations in stress in rocks associated with seismicity (Dickson, 1990; Baykara and Doğru, 2006). Therefore, radon gas is present in groundwater as a result of migration from rocks and soil in contact with the water (Kito et al., 1996). However, the radon gas diffusion from rocks and soil to well water is complex and both the water level and ventilation among other physical factors are important.

The fault zones are preferential pathways for fluid transport that may include gases such as radon, methane, helium, etc. (Moussa and El Arabi, 2003). The studies on the relationship between radon and seismicity were started by a Japanese scientist Okabe (Okabe, 1956). New instrumental developments leaded various geochemical effects to be examined as possible earthquake forerunners since the 1960s. Since earthquakes are physical phenomena, most of the techniques currently used for prediction purposes are based on geophysical approaches, including seismology, magnetism, electricity, and geodesy (Zmazek et al., 2002).

Since the 1960s, many studies on the prediction of earthquakes have been carried out by several researchers in seismically active countries such as China (Teng, 1980; King, 1985), Croatia (Planinic et al., 2004), Iceland (Hauksson and Goddard, 1981), India (Virk and Walia, 2001; Walia et al., 2003), Japan (Wakita et al., 1980; Igarashi et al., 1995), Jordan (Al-Tamimi and Abumurad, 2001), Poland (Swakon et al., 2005), USA (Mogro-Campero et al., 1980; Birchard and Libby, 1976, 1977, 1980; King, 1978; Shapiro et al., 1980; King et al., 1993) and Uzbekistan (Ulomov and Mavashev, 1971; Sadovsky et al., 1972).

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"Turkey is one of the most seismically active regions in the world. It is located within the 'Mediterranean Earthquake Belt', whose complex deformation results from the continental collision between the African and Eurasian plates" (İnceöz et al., 2006). In recent years, there have been some studies reported from Turkey on the radon concentration in groundwater because of the possible link to seismicity (Erees et al., 1997, 2006; Doğru et al., 2001, 2003; Belin et al., 2002; Baykara et al., 2005; Baykara and Doğru, 2006). Although Afyonkarahisar is located in the mid-western Anatolia where Akşehir fault zone lies, there is no study reported from Akşehir fault zone.

The determination of radon (^{222}Rn) concentration in well waters was carried out for the first time in Afyonkarahisar in Turkey. The aim of the present study is to determine a possible connection between eventual radon anomalies and active geological faults. The water sources investigated are used for drinking and irrigation purposes. Besides, this region has another importance since the city water is provided by municipality through the deep well waters.

2. Geological settings for study site

Water samples were taken from the wells located on the Akşehir fault zone as shown in Figure 1. In Fig. 1, the map of Turkey is shown at right top corner. Akşehir fault zone named by Koçyiğit (1984) lies between Konya in the east and Balıkesir in the west. General stretch of the zone is west–north west and east–south east and its total length is 420 km. Akşehir fault zone consists of normal fault zones which are 1–50 km length, parallel-semiparallel each other and mostly verve movement and its tangent decreases with the depth. There are many north–south and north west–south east stretch secondary short zones in the fault zone (Koçyiğit et al., 2000).

The fault zone has produced some destructive earthquakes whose magnitudes changes between 6.0 and 7.1 in Richter scale. These are namely 28th March 1970 Gediz earthquake with the magnitude of 7.1 in Richter scale, 15th December 2000 Sultandağı earthquake with the magnitude of 6.0 in Richter scale and 3rd February 2002 Çay earthquake with the magnitude of 6.5 in Richter scale.

3. Materials and methods

3.1. Sampling

Water samples were taken from 10 different State operated deep wells of the depth of 150 m between August 2003 and February 2004 with 10 different sampling runs. However, we should note that collecting samples were limited with the irrigation season for the region which is about seven months. One sample was normally taken at each well during each sampling run. Samples were collected in 0.5 l leak-tight plastic bottles by over filling and capping under the water to prevent any radon leakage. Before sample collection, each well was allowed to operate for at least 5 min to the environment.

3.2. Experimental measurements

In this work, sample analyses were carried out in Çekmece Nuclear Research and Education Center (ÇNREC). We applied

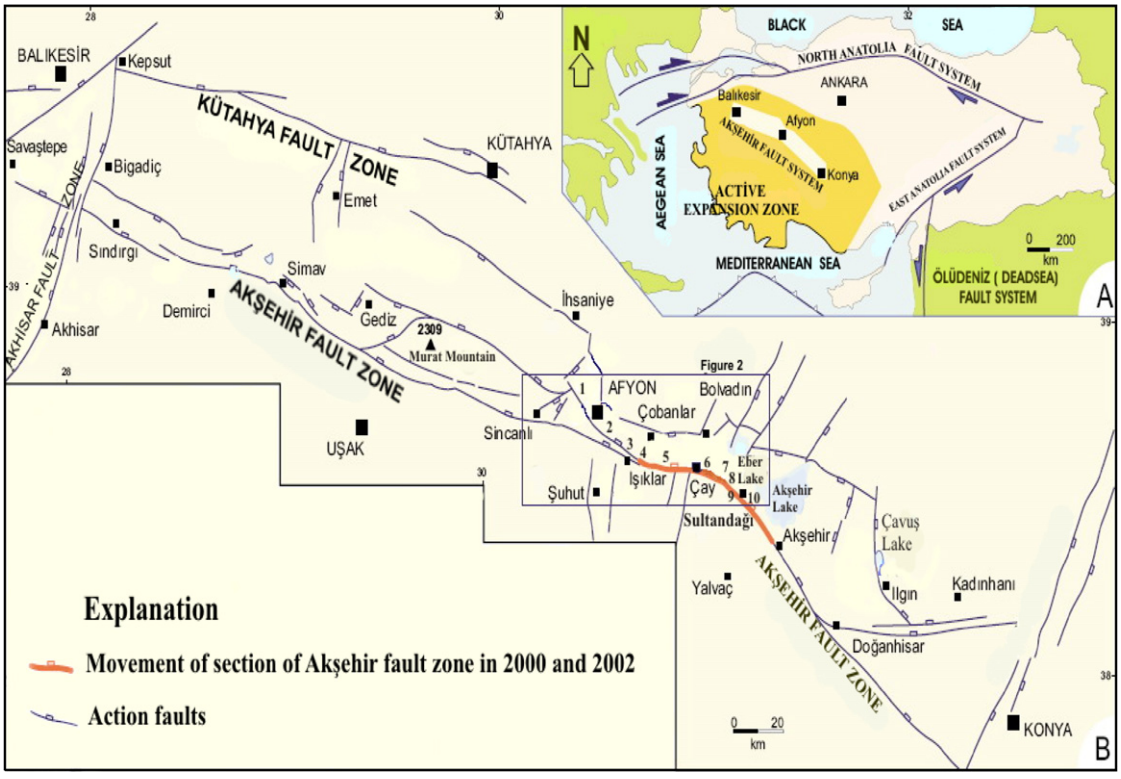

Fig. 1. The map of the study.