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Natural radionuclides monitoring in drinking water of Homs city

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HIGHLIGHTS

- Radon in drinking water was measured in houses and sources.
- Radon in houses ranged from 2.8 to 15.3 Bq/L and from 7.5 to 28.4 Bq/L in sources.
- Significant differences between sources and houses were found.
- Total alpha/beta and radium-226 content were within the international allowed limits.

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ABSTRACT

Radon concentrations, total alpha/beta and radium-226 content in drinking water of Homs city were measured at the sources and in some homes. Results showed that radon concentrations ranged from 2.8 to 15.3 Bq/L in homes and from 7.5 to 28.4 Bq/L in sources. In addition, the averages of total alpha, total beta, and radium-226 activity concentration were found for sources 260 ± 70 mBq\L, 220 ± 70 mBq\L and 45 ± 2 mBq\L and for homes 110 ± 30 mBq\L, 280 ± 180 mBq\L and 15 ± 1 mBq\L respectively. Significant differences in concentration were found between the sources and the homes. In general, all results showed that concentrations are within the international allowed limits.

1. Introduction

Radiation is a natural part of the environment in which we live. All people are exposed to the natural radionuclides in soil, water, air and food. The largest fraction of this exposure comes from the radioactive gas, radon (International Commission on Radiological Protection, 1991; Green et al., 1992). Radon is emitted from decay series uranium, naturally existed in rocks and soil; so radon is present virtually everywhere on the earth. Most of radon that enters a building comes directly from soil that is in contact with or beneath the basement or the foundation.

Radon is also found in water, and because it is easily released by agitation in water, many uses of water release radon into the indoor air, which contributes to the total indoor airborne radon concentration and to the total inhalation risk (Cothern and Rebers, 1990; Bodansky et al., 1987; Prichard and Gesell, 1981). In addition, drinking water contains dissolved radon and the radiation emitted by radon and its radioactive decay products exposes sensitive cells in the stomach as well as other organs once it is absorbed into the bloodstream (National Research Council, 1988; Hursh et al., 1965). Thus, radon in drinking water could potentially produce adverse health effects in addition to lung cancer (Weiffenbach, 1982).

Homs city is the third city in Syria in significant. Because it is in the middle of the country, it forms a junction between the other cities. It is about 450 m in height on the sea level. It is about 160 km north of the capital city of Syria, Damascus. It has a population about one million inhabitants. In the past, the source of drinking water was Al-Assi River. In 1970s, drinking water was replaced by the water of Ain Altanor spring. Because of increasing of population, it was supported by the water of Ain Alsamak spring. At the end of 1990s, ten wells were drilled at 30 km south of Homs to cover the necessity to drinking water. Fig. 1 shows Syria Map and the location of Homs city.

A national monitoring program in Syria was carried out since 1989. Measuring naturally radionuclide in drinking water was part of this program. Data presented in this work are the latest results obtained from the survey carried out in Homs city during 2008 and 2010.

2. Methods and measurements

The measurement of radon in water is relatively simple in compare to radon in air. The rate and magnitude of variations are

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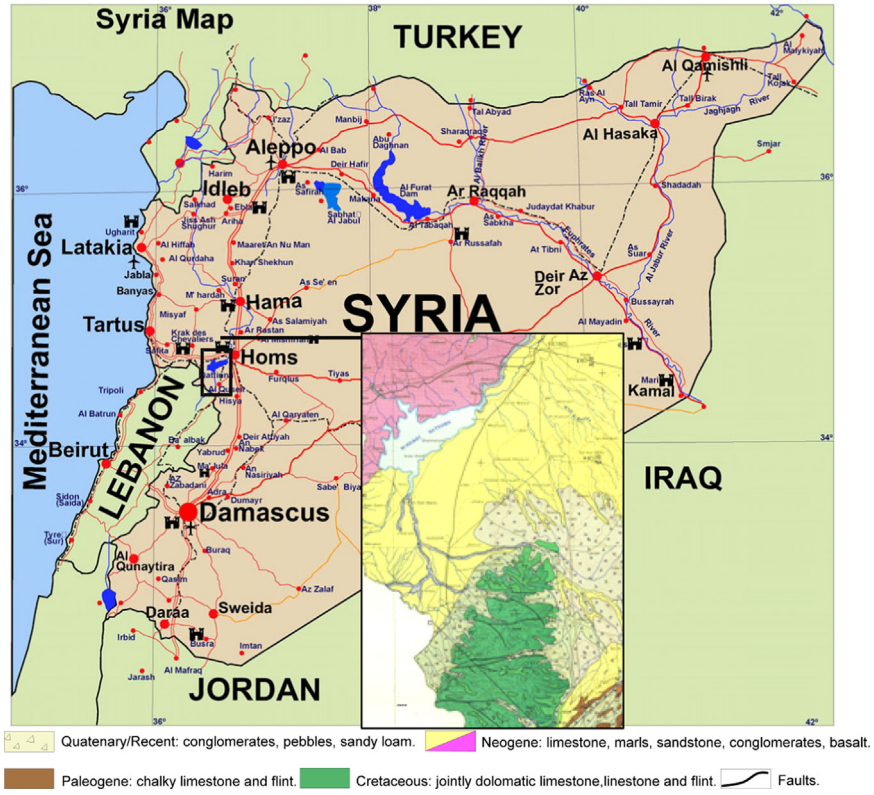

Fig. 1. Syria Map and the location of Homs city.

much lower, and there are fewer sampling problems. Nevertheless, the measurement of radon in water has its own set of sampling issues and analytical difficulties. All methods require correction for the decay of radon during the period between sampling and analysis: the following are common methods for radon measurements in water:

1. Liquid scintillation counters: Radon concentrations in water are typically much higher than the concentrations in air. When the radon concentration in water is sufficient high (> 1000 pCi/L), as is often the case with well water, direct liquid scintillation counting is a rapid and practical method (Richard Cothern, 1987). The water sample can be mixed with the counting material and counted by the conventional liquid scintillation counters used for radon in air samples. This method lends itself to large scale counting with automation.
2. Gas extraction (the method used in this study): A more sensitive method of detecting radon in water, suitable at lower concentrations, is to extract the radon as a gas and count the emitted alpha particles in a ZnS scintillation cell. Helium is bubbled through the water, striping the radon. The mixture of gases is then passed through a cold trap, for example activated charcoal at liquid nitrogen temperature, which traps radon while the helium passes through. The trap is then warmed and radon is transferred into a Lucas counting cell by stripping with a small amount of helium (Richard Cothern, 1987).
3. Direct gamma counting: When the radon concentration in water is relatively high (> 500 pCi/L), it is possible to determine the radon concentration by counting gamma rays from radon daughter decay using standard gamma-ray spectroscopy techniques with a Ge(Li) detector (Richard Cothern, 1987). The original radon concentration can be distinguished from the radium-226 concentration by repeating the count after 30 days, at which time the original radon will have virtually all decayed and the only remaining radon is that in secular equilibrium with radium-226.

In this study, Radon activity concentration, total alpha, total beta and radium-226 activity concentration were measured in the water for twelve sources supplying Homs City (Ain Altanor spring, Ain Alsamak spring and ten wells) and 25 samples from randomly selected homes distributed in the four directions of Homes City (North East, North West, South East and South West).

Gas extraction method was used to measure radon concentration. Different samples were collected from the sources and from homes to see if there is any difference in concentration. While, Radium-226, total alpha and total beta were measured in some samples by using liquid scintillation counter. The measurement methods are fully described by Forte et al. (2003). The results were compared with the recommended permissible values (1 Bq/L for Ra-226 and total Beta and 0.5 Bq/L, for total alpha) (World Health Organization, 2011).

3. Results and discussion

Table 1 presents the measurement results of Radon activity concentration, total alpha, total beta and radium-226 activity concentration. It is clear that Radon concentration in all sources of drinking water supplying Homs city ranged from 7.5 Bq/L to 28.4 Bq/L. The highest value, which could be considered as abnormal value (as all values obtained are less than 20 Bq/L) was from Ain Alsamak spring. This high value could be due to the fact that Ain Alsamak is located at the Sutter part between two Lebanon mount series. The fold mountain structures are alternate with intermountain depressions and associated with Deep-Seated Ramified faults system of NW-SE trend. The faults systems are cut the limestone, dolomite marly-limestone rock sequences of