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RESEARCH ARTICLE

CORRELATION BETWEEN RADIUM AND RADON IN THE DRINKING WATER SAMPLES OF MASHHAD-IRAN

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ABSTRACT

In this study, we have measured the radon and radium concentration in the more than 200 drinkable water sample collected around of Mashhad, specially the religion tourist sites like Khajeh Rabie, Khajeh Abasalt, Khajeh Morad Temples, Ferdowsi tomb, Torghabe, Trogh and Shandiz tourist tawns. The result shows that there is a significant correlation between radon and radium of water samples. The Radon is a liner function of the radium with a good liner correlation coefficient of 0.907.

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INTRODUCTION

Radium is a radioactive metal that occurs naturally in trace amounts in rocks, soils, and ground water. As radium decays, it continually releases energy into the environment until a stable, nonradioactive substance is formed. This energy is part of the natural radiation to which all living creatures are exposed. Radium readily dissolves in groundwater where acid conditions, low pH levels, are found. The various forms of naturally occurring radium found in groundwater are radium 224, 226, and 228. We well know that its next decay element is radon (EPA, 1991; Cantor, 1997). Radon radioactive gas is arising from the uranium and thorium natural decay chains, and it is the largest source of radiation exposure to population. High radon exposures have been shown to cause lung cancer and it is the second leading cause of lung cancer in the United States, next to smoking. Radon gas and its radioactive daughters can attach themselves to tiny dust particles in indoor air. These dust particles can easily be inhaled and the deposited atoms by emitting alpha cause radiation damage to lung cells (Cantor, 1997; Minkin and Shapovalov, 2008). The U.S. Environmental Protection Agency, EPA, has established Maximum Contaminant Levels (MCLs) for uranium and radium. The MCLs are enforceable drinking water standards determined by balancing the adverse health effects of a particular substance

against the feasibility and costs of treating contaminated water. There is a provisional MCL for radon, which has draft status and is, therefore, non-enforceable. The MCL for uranium is 30 ppb based on its potential to accumulate in the kidney and damage it. The MCL for radium is 0.2 Bq/L based on its potential to cause cancer (EPA, 1997). The provisional MCL for radon is 11 Bq/L based on its potential to cause lung cancer. Because the EPA realizes that an individual's risk from radon exposure is actually the sum of exposures from indoor air, originating primarily from radon in soil gas migrating into homes, and from drinking water, the EPA has also proposed an Alternative Maximum Contaminant Level (AMCL). The AMCL would allow up to 148 Bq/L of radon in drinking water if radon exposure from indoor air was also considered and reduced, if necessary (EPA, 1997).

MATERIAL AND METHODS

Measurement of radon concentration in the water samples

We have used the PRASSI Model 5S system to measure radon and radium concentration in the drinking water samples. The system consists of a 1830 ml cell coated with zinc-sulphide activated with silver AnS (Ag) coupled with a low-gain-drift photomultiplier. The cell characteristics provide the detection of very low radon concentration levels in the sampled air. The PRASSI pumping circuit operates with constant flow rate of 3 liters per minute for degassing the water sample properly. The sensitivity of this system in continuous mode is 4 Bq/m^3 during the integration time of 1 hour. The system set up of measurement including bubbler and drier column is shown in Figure 1. As well as, the last recalibration of the system has been done by radiation lab of Iranian Atomic Agency at fall 2008.

Radium health effect and measurement of its content in the water samples

The National Academy of Sciences in USA has concluded that long-term exposure to elevated levels of radium in drinking water may result in an increased risk of bone cancer (EPA, 1997).

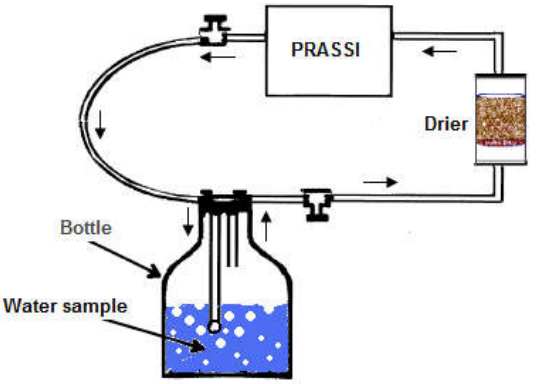

Fig. 1. The radon measurement set up.

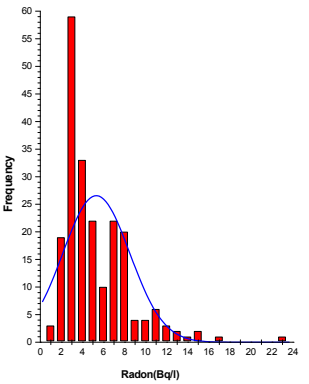

Fig. 2. The histogram of radon concentration in the water samples.

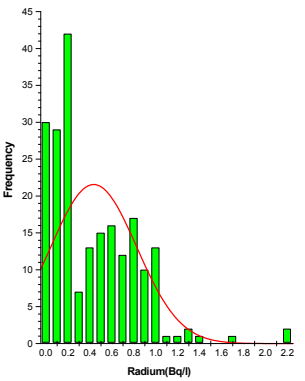

Fig. 3. The histogram of radium concentration in the water samples.

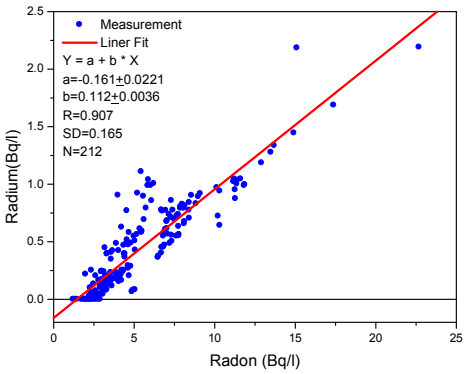

Fig. 4. Linear correlation between radon and radium in the drinking water samples.

When ingested into the body from drinking water, radium can accumulate in the bones; like calcium does from milk. When consumed in high doses, or at a lower dose extended over a lifetime, the risk increases. To measure the radium content of samples, we kept the full bottles of water sample for about 3 weeks after radon degassing. Due to the decay of radium, during of this time it is equilibrium with radon. So, by measuring of radon we have obtained the radium content of the water samples. The average value of three measurements was considered as the radon concentration in the water sample.

RESULT AND DISCUSSION

In this study, we have measured the radon and radium concentration in the more than 200 drinkable water sample collected around specially the religion tourist sites like Khajeh Rabie, Khajeh Abasalt, Khajeh Morad temples, Ferdowsi tomb, Torghabe, Trogh and Shandiz tourist towns near side of Mashhad. The histogram of the radon concentration in the samples has been presented in the Fig. 2. According to the obtained data, the minimum, maximum and arithmetic mean of radon concentrations in the samples are 1.22, 22.69 and 5.32 Bq/l, respectively. As well as a few samples (around 7%) have the radon level more than the EPA advised level, 11 Bq/l. Fig. 3 shows the histogram of radium concentration in the water samples. According to the Maximum Contaminant Level for Radium (0.2 Bq/L), the result shows that 78% of samples have the radium contamination more than this level. Fig. 4 shows a good linear correlation between radon and radium in the drinking water samples with 0.907 linear regressions.

Conclusion

Radon and radium concentration in the more than 200 drinkable water samples around of Mashhad have been measured. The result shows that there is a significant correlation between radon and radium of water samples. The Radon is a liner function of the radium with a good liner correlation coefficient of 0.907. According to the obtained data, the minimum, maximum and arithmetic mean of radon concentrations in the samples are 1.22, 22.69 and 5.32 Bq/l, respectively. As well as a few samples (around 7%) have the radon level more than the EPA advised level, 11 Bq/l. As well as, 78% of samples have the radium contamination more than the Maximum Contaminant Level for Radium (0.2 Bq/L).

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