ON THE SIMULTANEOUS INDOOR MEASUREMENT OF THE EXHALATION RATES OF RADON GAS FROM OPEN SOIL AND THE CONCENTRATION OF RADON PROGENY IN THE SURROUNDING AIR

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INTRODUCTION

It is well known that the outdoor measurements of radon exhalation rates and of radon concentration in atmosphere are affected by the temperature, wind and atmospheric pressure (1). So far, no clear correlations have been found between these measurements. However, with indoor measurements, especially those recorded in a basement, the temperature is constant and the air flow minimal. This means that we can expect radon exhalation rates and the concentration of radon progeny to be affected by atmospheric pressure alone.

Taking these environmental conditions into account, the simultaneous measurement of radon exhalation rates and radon concentrations was performed in the basement of SUT (Science University of Tokyo), Oshamanbe campus in order to clarify the nature of the relationship between radon exhalation rates and concentrations and changes in atmospheric pressure. Atmospheric pressure was also measured simultaneously with the above measurements. The present measurements were carried out during the winter, spring, summer and autumn of 1995. Measurements were made in a series of one week periods.

EXPERIMENT

As far as we know, there are few studies based on indoor measurements of radon exhalation rates from the soil. This is because the exhalation source, that is the soil, is essential to measurement, and earth-floored basement areas are seldom found in modern building construction. Fortunately, this campus has a large earth-floored basement room (24 m X 22.4 m X 2.6 m). This was the ideal environment for the measurement of radon exhalation rates from the soil and radon progeny concentration in the surrounding air. Our basement has an exhaust fan, which is turned off between midnight and 5:00 a.m.

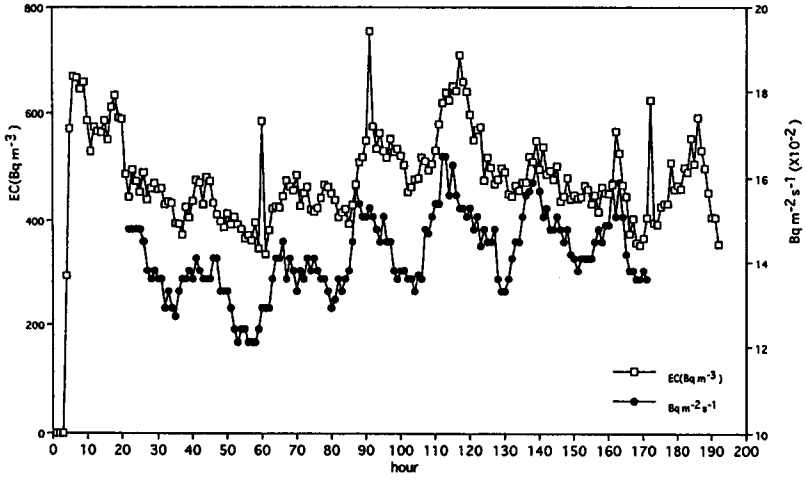

Figure 1. Simultaneous measurement of radon exhalation rates (Bq $m^{-2}s^{-1}$) and radon concentrations [EC(Bq m^{-3})], 17th-23rd May 1995.

The exhalation rates of radon gas from the soil were measured using an ionization chamber (2), whose efficiency was calibrated with a standard radon gas. The ionization currents yielded in the ionization chamber were continuously marked on recording paper. The ionization currents were then converted into exhalation rates in units of Bq $m^{-2}s^{-1}$. The collector of the ionization chamber (covering area 0.85 m X 0.25 m) was placed on the ground surface around the center of the basement room.

The concentrations of radon progeny in the surrounding air were measured using a Radon WL Meter (Thomson & Nielsen Electronics Ltd). The α - ray counts in the Radon WL Meter were measured as they accumulated every hour, and the data processed by an internal computer program. The results were printed out on the recording paper in units of EC(Bq m^{-3}), i.e. Equilibrium-Equivalent Concentration. In order to monitor the concentration of radon gas in the surrounding air near the Radon WL Meter, a dozen "Rad Track" detectors were also fixed at the same time near the inlet of the Radon WL Meter. The Radon WL Meter was set on a table at a height of 0.8 m.

RESULTS and DISCUSSION

As shown in Figure 1, it was found that the upward and downward trends of the radon concentration obtained in the surrounding air were correlative to variations in the radon exhalation rates from the open soil. In other words, the radon concentrations were found to be in phase with the radon exhalation. Sporadic spikes were observed in the tracking curves of the radon progeny concentrations, as shown in Figure 1. The reason for their occurrence is not apparent to the present authors.

Atmospheric pressure affected the yields both of the radon gas from the soil and of the radon progeny concentrations in the air. Whenever atmospheric pressure increased, both the yields of radon gas and of radon concentration decreased, and vice versa. That is, the former tracking curve varied with the latter curves in an inverse relation. An example of this phenomenon is shown in Figure 2.

Periodic daily variations were clearly observed in the tracking curves of both the exhalation rates of radon gas and the radon concentrations, as shown in Figure 2 and Figure 3. The peaks of the radon exhalation rates in Figure 2 and of the radon concentration of (no.1) and (no.2) data in Figure 3 occurred at about 6:00 a.m. every day. The data of (no.1) and (no.2) were obtained simultaneously by two different Radon WL Meters, which were set on tables at the center and corner points of the basement room, respectively.

Seasonal variations in radon exhalation rates from the soil are shown in Figure 4. The autumn level of the radon exhalation rates was the highest, while those in winter and spring were median. The lowest rates were exhibited by the data observed in the summer.

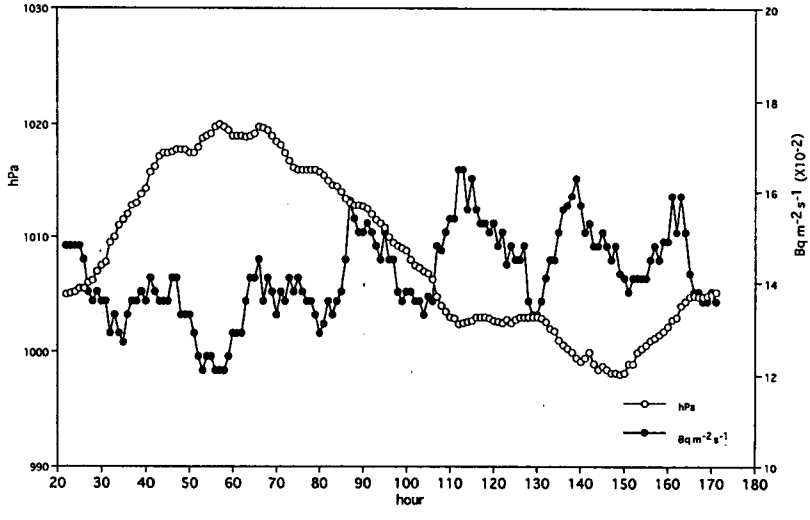

Figure 2. Dependence of radon exhalation rates (Bq $m^{-2}s^{-1}$) from soil on changes in atmospheric pressure (hPa), May 17th-23rd 1995.

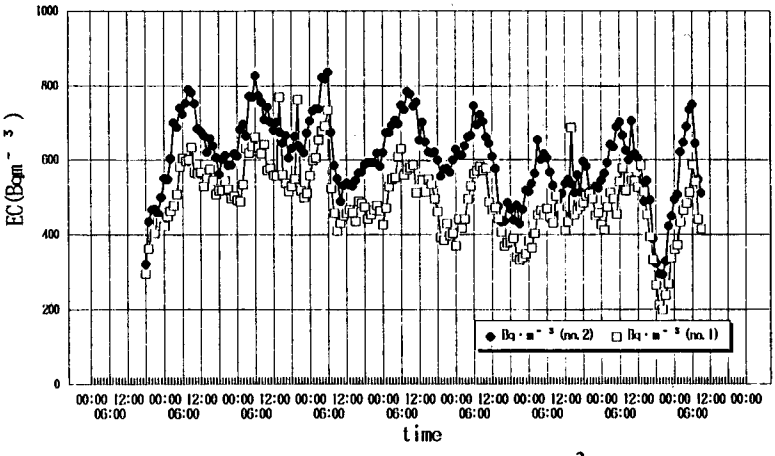

Figure 3. Daily variation of radon concentration [EC(Bq m^{-3}] in air, July 28th-August 5th 1995. The data of (no.1) and (no.2) were obtained at the center and corner points, respectively, in the basement room. Two different Radon WL Meters were used simultaneously. The peaks of radon concentrations occurred at about 6: 00 a.m. daily.

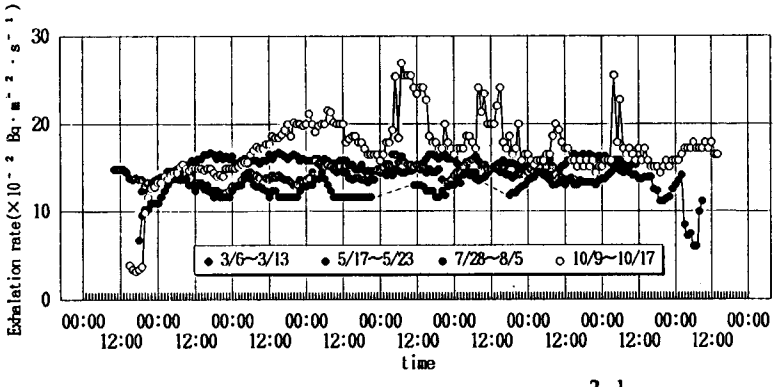

Figure 4. Seasonal variations in radon exhalation rates (Bq $m^{-2}s^{-1}$) from soil during winter, spring, summer and autumn 1995.

The radon concentrations (Bq m^{-3}) obtained by "Rad Track" detectors were compared with the integrated values estimated from the tracking curves of the radon concentrations [EC(Bq m^{-3})]. The results show that the latter values were about 1.7 times greater than the former.

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2. T. Itaya, T. Tanji, and S. Mochizuki, *J. Nucl. Sci. & Tech. Japan* 32, 944-946 (1995).