Distribution of Radon Levels in Udaipur

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In the present study, measurements of radon concentrations have been carried out in dwellings of Udaipur town situated in Rajasthan - province of Northern India. According to Geological survey of India, this place falls in the pre-Cambrian rocks in Aravalli mountain range. The trace element analysis indicates higher percentage of natural uranium. The survey was made in randomLy selected fifty-seven (57) dwellings in Udaipur town. LR-115 type II track–*etch* detectors in bare mode were exposed for 100 days in each dwelling. Analyses of the present data yield an aggregate distribution with an average (arithmetic mean) radon concentration of 99 $Bq.m^{-3}$. The geometric mean values of total potential alpha energy concentration in this town was found to be 74 $Bq.m^{-3}$ with geometric standard deviation of 2.2 as well as the minimum and maximum radon concentrations encountered in the study are in the range of 61-277 $Bq.m^{-3}$.

Key Words: Uranium, Radium-226, Radon, Radon progeny, LR-115 track detector

INTRODUCTION

Radon (^{222}Rn) through its radioactive progeny has long been known to be a causative agent for lung cancer prevalent in uranium miners[1]. Radon is natural product (inert gas) of the radioactive decay of uranium. In several countries it is now acknowledged as second important cause of lung cancer after smoking. High indoor radon activity is believed to contribute significantly to lung cancer. However, several cases of control and ecological studies on the relation between domestic radon exposure and lung cancer have shown conflicting results[2-4]. ^{226}Ra present in soils and rocks is the main source of indoor radon and its progeny, with the additional emission from building materials, water and natural gas, representing a relatively small contribution to indoor radon exposure. The emanation of radon from the soil depends not only on the ^{226}Ra content but also on the nature of the host mineralogy, the porosity, the grain size, the moisture content and the permeability of the host rock and soil[5,6]. This paper reports the measurements of Potential Alpha Energy Concentration (PAEC) due to radon progeny in 57 dwellings in Udaipur town situated in the Rajasthan province of Northern India.

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EXPERIMENTAL

The passive time integrated method of using a solid state nuclear track detector whose details are given elswhere[7,8] was employed for measuring the PAEC of radon daughters in working level (WL) units. Kodak LR-115 type-II detector was used in bare mode. The piece of the detector film (2 × 2 cm) fixed on the thick flat card was exposed in bare mode by hanging the cards on the wall of the dwelling for a period of 90 days so that the detector viewed a hemisphere of air of radius at least 6.9 cm, the range of ^{214}Po α-particle in air. No surface should be closer than this range. The track density in bare mode detector will, therefore, be a function of radon daughter concentration in air. To know the PAEC of radon daughters in mWL it is essential to calibrate the detectors in a known Rn concentration under most similar conditions to those, which prevail in Indian dwellings. For this purpose, the detectors were calibrated in a radon exposure chamber at Environmental Assessment Division of Bhabha Atomic Research Centre, Bombay. The details of the experiment are given elsewhere[7]. The mean calibration factor for LR-115 type-II detector was found to be 442 ± 60 tracks cm^{-2} d^{-1} per WL. After the exposure, the detectors were brought back to the laboratory and chemically etched in 2.5 N NaOH solution at 60 ± 1^{0}C for 90 min in a constant temperature water bath. The resulting tracks were counted by using optical research microscope under magnification of 400x.

RESULTS AND DISCUSSION

The summary of the results of these measurements carried out in 57 dwellings is presented in Table-1. Analyses of the present data yield an aggregate distribution with an average (A.M.) radon concentration of 99 Bq m^{-3}. The geometric mean value of total potential energy concentration in this town was found to be 74 Bq m^{-3} with geometric standard deviation of 2.2 as well as minimum and maximum radon concentrations encountered in the study are in the range of 16-277 Bq m^{-3}. The normal probability plots for radon concentration in Udaipur is shown in Fig. 1

TABLE-1
RADON CONCENTRATION IN THE DWELLINGS OF UDAIPUR

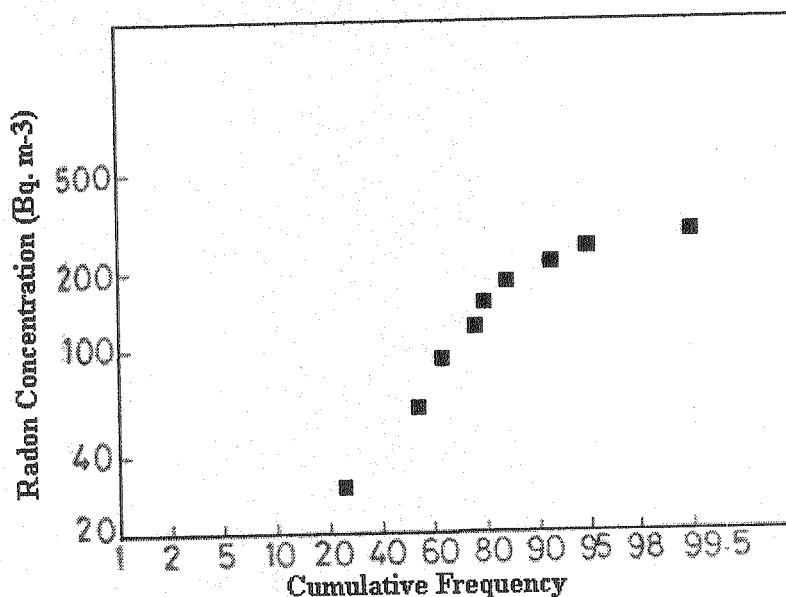| S.No.	No. of dwellings	Rn Concentraion (Bq m^{-3})				GSD
		AM	SD	GM	Range	
1.	57	99	74	74	16-277	2.2

Fig. 1. Normal probability plots for houses in Udaipur, Rajasthan

The points appear to fall almost on straight line indicating that the radon measurements are approximately log-normally distributed. The distributions in this place of study cannot be considered as representative either for Indian dwellings or for the population exposure. The reason for this is that the G.M. of radon concentrations in these measurements was found to be higher as compared to the other parts of the country[8-11]. However, the radon levels were comparable to our study in the dwellings of hilly regions[11]. This may be attributed to the different geological parameters of the regions.

According to Geological Survey of India, this place falls in the pre-Cambrian rocks in the Aravalli mountain range, which can be grouped in Banded Gneissic complex and Aravalli super group. In Aravalli super group workable phosphorite deposits are present in significant amount. These phosphorites are invariably associated with dolostones and their P_2O_5 contents vary from 5 to 23%. Trace elements analysis also indicates higher percentage of natural uranium.

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