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RADON LEVELS INSIDE RESIDENCES IN MEXICO CITY

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ABSTRACT

Levels of radon were measured during winter and spring seasons inside 55 colonial and modern houses and 30 multifamily apartment buildings representative of middle and upper income families. The modern houses and apartment buildings in the southern section of the city had average radon levels exceeding 150 Bq m^{-3} with a maximum single measurement of 458 Bq m^{-3}. The colonial houses in the central downtown section had radon levels nearly all averaging below 100 Bq m^{-3}. Between the ground and third floor of the apartment buildings, radon levels diminished by tenfold indicating that entry of radon-bearing soil gas was largely responsible for the elevated concentrations of radon. The radon levels in winter exceeded by about 30% the radon levels during spring. The potentially adverse health effects of these radon levels may be exacerbated by the quality of air in Mexico City which during winter is often highly polluted.

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INTRODUCTION

Indoor exposures to radon have received considerable attention in European countries and in the U. S. The latter country recently established the goal of reducing indoor radon levels to outdoor ambient levels (1) reflecting concern that radon is perhaps the greatest environmental cancer threat to the general population. There have also been extensive measurements to establish geographical patterns of indoor radon levels in developed countries (2). In developing countries, such as Mexico, there have been more meager attempts to define indoor radon problems. The currently reported study is a modest attempt to rectify this deficiency in the Mexican capital where about one quarter of the nation's populace resides.

RADON MEASUREMENTS

Nuclear track detectors composed of CR-39 (Pershore Molding Ltd., England) were used to measure integrated exposures to radon. The pretreatment, etching, and counting procedures have been described (3).

One detector at a time was placed in a room where a radon measurement was being made. The detector was exposed for one month and then immediately replaced with a new detector. Measurements were made during the winter and spring seasons. In each residence, measurements were made in the living room, dining room and bedroom closest to ground level. Multiple detector measurements were made at single locations; the measurement precision was ±20% at radon concentrations in excess of 100 Bq m^{-3}.

RESIDENCES

Three types of residences were studied. Twenty-five single family homes were older colonial-style houses situated in the central zone of the city. Thirty single family homes were of contemporary style, built on hillsides in the southern section of Mexico City. Thirty apartments were in multifamily, multistory buildings, located south of the city center.

RESULTS AND DISCUSSION

The indoor measurements of radon in single and multifamily dwellings are tabulated in Tables 1 and 2, respectively. There are several salient features. In the southern sections of Mexico City, the average wintertime levels of radon range between 175 and 348 Bq m^{-3}. These levels of radon were found in both modern houses and in apartment buildings at the ground level. The U.S. Environmental Protection Agency recommends considering remedial action within a few years if radon levels are between 150 Bq m^{-3} (4 pCi/L) and 740 Bq m^{-3} (20 pCi/L) (4). If the radon levels are higher then remedial action is recommended within months, or even weeks if measurements reveal 7400 Bq m^{-3} or higher. In Mexico, the federal agencies have yet to establish similar guidelines. In fact the present study is the first moderately extensive attempt to evaluate existing residential radon problems in Mexico City.

The radon levels in colonial-type residences in the central section of the city averaged well below 150 Bq m^{-3}. The highest single measurement was 156 Bq m^{-3}. The lower radon levels in the lower lying central zone probably reflect the lakebed origin of the underlying soil; either the radium content of lakebed sediment is less than that in the higher, rockier ground of the southern sections

or the soil permeability is lower. The current study involves only 55 out of the more than 2.5 million buildings in Mexico. The study does no more, therefore, than point to radon problems of moderate significance existing in regions elevated above the old lakebed section of Mexico City. Taking the single highest seasonal reading in each of the total 55 residences, 45% of these residences exceeded 150 Bq m^{-3}. If such an evaluation is restricted to residences in the southern sections of the city, then the percentage rises to 60%.

The measurements of radon in the multifamily apartment buildings were made on the ground, first, second, and third floors. The radon concentration was distinctly greater at the ground level. There are decrements in radon concentration of about 50% between successively higher floors. This trend indicates that the principal source of indoor radon is likely to be soil gas entering the building at ground level. The importance of pressure-driven flow of air through soil and into buildings has been well established by U. S. investigators (5,6). A secondary source of indoor radon is associated with the natural radioactivity of the bricks, concrete and gravel used in construction of houses in Mexico City (3). Stone and stone products are used extensively in their construction. Most of these items are made with materials excavated locally.

The average levels of radon are approximately 30% higher in winter compared to the spring. The indoor "thermal stack effect" (7) is usually invoked to explain higher radon levels during wintertime in colder climates. The winter in Mexico City remains relatively mild and the custom is to use indoor heating only irregularly, or not all. The indoor "thermal stack effect" may not be underlying reason for the higher wintertime radon levels; rather, the stagnant, windless atmospheric conditions typical of the winter season in Mexico City may be contributing to poor ventilation and allowing accumulation of radon. All houses in the study rely on natural ventilation.

There is marked buildup of urban atmospheric pollutants during temperature inversions affecting Mexico City in the wintertime. The potential for synergism between dirty city air and elevated indoor radon levels in increasing risk of lung cancer only adds to the need for more thoroughly evaluating radon levels in Mexico City in the future.

CONCLUSION

Indoor radon levels have been measured in 55 residences within Mexico City using integrating track etch detectors. Significant levels of radon (>150 Bq m^{-3}) were found inside buildings away from the center of the city with levels higher during winter than spring. Expanded studies are needed to determine the extent and severity of radon problems in other sections of the Federal District, as well as in the 31 other states of Mexico.

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Table 1. Levels of Radon (Bq m^{-3}) in Single Family Residences

House Type/Room	Minimum		Maximum		Average	
	Winter	Spring	Winter	Spring	Winter	Spring
Colonial/Living	18	15	83	58	62	49
Colonial/Dining	18	15	97	63	75	52
Colonial/Bedroom	35	21	156	112	107	89
Modern/Living	83	77	275	210	180	127
Modern/Dining	71	77	260	210	163	127
Modern/Bedroom	210	160	458	356	348	272

Table 2. Levels of Radon (Bq m^{-3}) in Multifamily Apartment Buildings

Floor/Room	Minimum		Maximum		Average	
	Winter	Spring	Winter	Spring	Winter	Spring
Ground/Living	125	91	337	210	225	187
Ground/Dining	125	91	352	210	232	187
Ground/Bedroom	122	72	214	152	175	110
First/Living	63	43	120	91	98	70
First/Dining	60	40	120	97	93	72
First/Bedroom	48	26	79	57	65	48
Second/Living	22	16	59	46	47	32
Second/Dining	20	15	60	46	48	32
Second/Bedroom	12	11	29	18	23	15
Third/Living	15	12	27	20	21	18
Third/Dining	15	10	29	21	22	17
Third/Bedroom	9	4	17	15	13	10