DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Radon soil-gas survey in Prince Georges County, Maryland

by

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Open File Report 88-52

This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey publication standards and stratigraphic nomenclature.

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1988

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Abstract

Soil-gas samples collected along a traverse in Prince Georges County, Maryland were analyzed for radon. The traverse included principal lithologies and areas for which aeroradiometric measurements showed various intensities. Although, in the past, this region in the Coastal Plain province had not been considered to possess the type of geologic setting or aeroradiometric signature that would contribute to significant indoor accumulations of radon, the measured soil-gas concentrations of up to 2500 pCi/L (picocuries per liter) indicate that the potential exists for indoor accumulations in excess of the 4 pCi/L level established by the U.S. Environmental Protection Agency. The higher levels of soil-gas radon were found in some of the Tertiary sediments with the lower concentrations in the Cretaceous and Quaternary sediments. Geologic relationships are thought to be the controlling factors for the radon soil-gas concentrations. Although very few indoor radon data are available for Prince Georges County, they, too, indicate levels exceeding the 4 pCi/L guideline in areas underlain by some Tertiary formations but less for the Cretaceous and Quaternary formations.

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Introduction

Radon, a radioactive gas that is a product of the decay of radium, has been found to accumulate in some homes at concentrations that are considered to pose a health risk (Environmental Protection Agency, 1986). Factors causing the gas to accumulate in homes are numerous and range from the manner of house construction to the concentration of radium in the soil or bedrock upon which the house is built. Radon, as a mobile gas, does not migrate very far from its radium parent because of its short half-life. Radium itself is derived from the radioactive decay of uranium or thorium, the concentration and distribution of which is strongly controlled by petrologic conditions during rock and mineral forming processes. Geology and soil chemistry are then dominant in controlling the surficial, natural distribution of radium.

Prince Georges County, Maryland lies in the Atlantic Coastal Plain Province. In the region of this study, the underlying sediments are deltaic and marine in origin and consist of clay, sand and gravel of Cretaceous, Tertiary and Quaternary age. The sediments dip gently to the southeast and the present day drainage is toward the south-southeast. In general, the age of the exposed sediments increases toward the west. Figure 1 shows the location of samples on a geologic map for the county based on the work of Hack (1977). No known faults intercept the surface but Jacobeen (1972) has interpreted seismic evidence for high angle reverse faulting at depth.

Clean, silicious, non-organic marine sedimentary rocks have not been considered to be a source for high radon emanation and indeed the natural radioactivity for this area is fairly low (Neuschal, 1965) when compared to areas containing crystalline rocks such as Montgomery County immediately to the west. Very few homes in Prince Georges County have been tested for indoor radon and some exceed the level of 4 pCi/L (picocuries per liter) established as a guideline by the U. S. Environmental Protection Agency (EPA). No indoor concentrations reported to date exceed 40 pCi/L.

Analytical Technique

The sample collecting and analytical techniques were as described by Reimer and Bowles (1979) and Reimer and Gundersen (in preparation) for making a rapid field assessment of soil-gas radon concentrations. Basically, the method consists of pounding a hollow steel probe into the ground to a depth of 0.75 meter and withdrawing a 10 cm^3 sample with a hypodermic syringe. The sample is then injected into an evacuated, phosphor-coated cell and counted with a portable alpha-particle scintillometer (Reimer, 1977). The analytical unit had been calibrated using the U.S. Bureau of Mines radon test facility in Denver, Colorado. The short-lived radon isotopes were allowed to decay before introducing the sample to the cell and only ^{222}Rn concentrations were measured. The accuracy of the radon concentrations are $\pm$ 50 pCi/L.

Indoor radon concentrations were measured by various techniques. These 21 data were provided on a voluntary basis by the individual homeowners. The exact locations are not known, only the geologic formations in which the homes were built. No indoor radon concentrations are available from locations along the traverse so direct correlations between indoor radon and soil gas radon are not possible.

Data and Discussion

A total of 48 soil-gas samples were collected on the approximate 20 kilometer traverse (Figure 1). The soil-gas radon concentrations range from 100 to 2700 pCi/L with an arithmetic mean of 750 pCi/L. Table 1 gives the radon concentrations for the individual samples sequenced from west to east. Figure 2 shows frequency histograms of the soil gas and indoor radon distribution for the specific geologic formations from which the samples were collected. The Tertiary formations show the greatest range in concentrations although the data are too few to truly characterize the distribution. Figure 3 shows a summary distribution of the radon concentrations for the specific formations, again with many having few data points. The highest concentrations are associated with the Chesapeake Group (Tc) and the Aquia Formation (Ta). The Chesapeake Group consists of light-colored, fine to very fine marine sand, silt, clay, and thin layers of diatomaceous earth although the latter have been described as principally occurring south of the traverse location. The Aquia Formation is a greenish-grey clayey sand comprised mostly of quartz and glauconite. It is crossbedded and contains layers cemented by iron and shell layers cemented by carbonate. The Upper Member of the Nanjemoy Formation (Tn) also contains glauconite but was not sampled during this survey. The Marlboro Clay Member of the Nanjemoy Formation (Tmb) is reported to contain glauconite sand also but only in the upper 1 meter portion and it is restricted to filling in tubes or burrows. Higher concentrations of radioactive elements can be concentrated in glauconite and diatomaceous earth (Sverdrup and others, 1942). That this is the case with these particular sediments in Prince Georges County is suggested by the radon data. Specific chemical analyses for radium and uranium would reveal if this association is correct.

The soil-gas radon traverse transected several zones of different radioactivity intensities revealed in the gamma aeroradioactivity map of Neuschel (1965). The highest gamma radiation along the traverse is associated geologically with a portion of the Tertiary Brightseat Formation and Monmouth Group (TKb), a marine sand and clay also containing glauconite. The mean radon concentration for the four soil-gas samples from this formation is 800 pCi/L, only slightly higher than the mean of 750 pCi/L for the entire data set. There was not an observable correlation between the soil-gas radon and the higher gamma aeroradioactivity signature.

The upper limit of radon soil-gas concentrations observed in this study corresponds to some concentrations found in regions of the Reading Prong in Pennsylvania and New Jersey (Gundersen, 1987, unpublished data; Gundersen, Reimer and Agard, in preparation), and in Montgomery County, Maryland and Fairfax County, Virginia (Schumann and Owen, in preparation) where houses with high indoor radon concentrations are located. A result of those previous studies indicated that a significant proportion of houses had high indoor accumulation of radon when constructed in areas where the soil-gas radon concentration exceeded about 2000 pCi/L. Furthermore, those studies indicated that the most reliable indicator of predictability for indoor radon was geology supported with soil-gas radon surveys. This appears to be the case with Prince Georges County as well. The radon soil-gas survey shows that soils derived from certain lithologies have the potential of supplying sufficient radon capable of creating an indoor radon accumulation in excess of the EPA guideline.

Conclusions

A reconnaissance radon soil-gas survey in Prince Georges County, Maryland has revealed several Tertiary Formations that have radon concentrations in excess of 2000 pCi/L. This level is one at which elevated indoor radon concentrations can be expected based on measurements in other areas of the United States. The majority of the county, projecting from the areal distribution of the various geologic formations, would appear to have low concentrations of soil-gas radon. Additional work should be done to see if the correlation between geology and soil-gas radon extends to other regions of the county. This work should be in sufficient detail to reveal the scale of the radon soil-gas distribution in order to evaluate if it is a localized phenomenon or common to the specific lithologies. It should also include spectral gamma readings and soil chemistry to develop a data base to assist in predicting areas with the potentially high radon.

Acknowledgments

The field work was suggested by Jim Otton and was conducted with the assistance of Josh Been, Mitch Henry, and Sandy Szarzi.

Table 1. Soil-gas radon concentrations for the traverse in Prince Georges County, Maryland. The sample locations are shown in Figure 1 and the values are sequenced from west to east with reference to that figure.

SEQUENCE NUMBER	RADON CONCENTRATION (pCi/L)
1	250
2	150
3	1100
4	100
5	900
6	500
7	700
8	1050
9	1000
10	700
11	1000
12	500
13	450
14	500
15	1050
16	950
17	100
18	350
19	850
20	100
21	100
22	500
23	700
24	450
25	400
26	550
27	200
28	650
29	900
30	950
31	150
32	1700
33	700
34	1600
35	2700
36	800
37	1050
38	2050
39	250
40	750
41	650
42	100
43	1300
44	1450
45	950
46	950
47	150
48	800

References

Gundersen, L. C. S., Reimer, G. M., and Agard, S. S., in preparation, Correlation between geology, radon soil gas and indoor radon in the Reading Prong.

Hack, J. T., 1977, Geologic map for land-use planning, Prince Georges County, Maryland: U.S. Geological Survey Miscellaneous Investigations Series Map I-1004.

Jacobeen F. H., Jr., 1972, Seismic evidence for high angle reverse faulting in the Coastal Plain of Prince Georges and Charles County, Maryland: Maryland Geological Survey Information Circular 13, 21 p.

Neuschel, S. K., 1965, Natural gamma aeroradioactivity of the District of Columbia and parts of Maryland, Virginia, and West Virginia: U.S. Geological Survey Geophysical Investigations Map GP-475.

Reimer, G. M. and Bowles, C. G., 1979, Soil gas helium concentrations in the vicinity of a uranium deposit, Red Desert, Wyoming: U.S. Geological Survey Open-File Report 79-975, 9 p.

Reimer, G. M., 1977, Fixed volume gas inlet system for an alpha-sensitive cell adapted for radon measurement: U.S. Geological Survey Open-File Report 77-409, 3 p.

Reimer, G. M. and Gundersen, L. C. S., in preparation, A direct correlation between indoor radon, soil gas radon and geology in the Reading Prong, Pennsylvania.

Schumann, R. R. and Owen, D. E., in preparation, Relationships between geology, equivalent uranium, and radon in soil gas, Fairfax County, Virginia.

Sverdrup, H., Johnson, M. W., and Fleming, R. H., 1942, The Oceans, John Wiley and Sons, New York, New York.

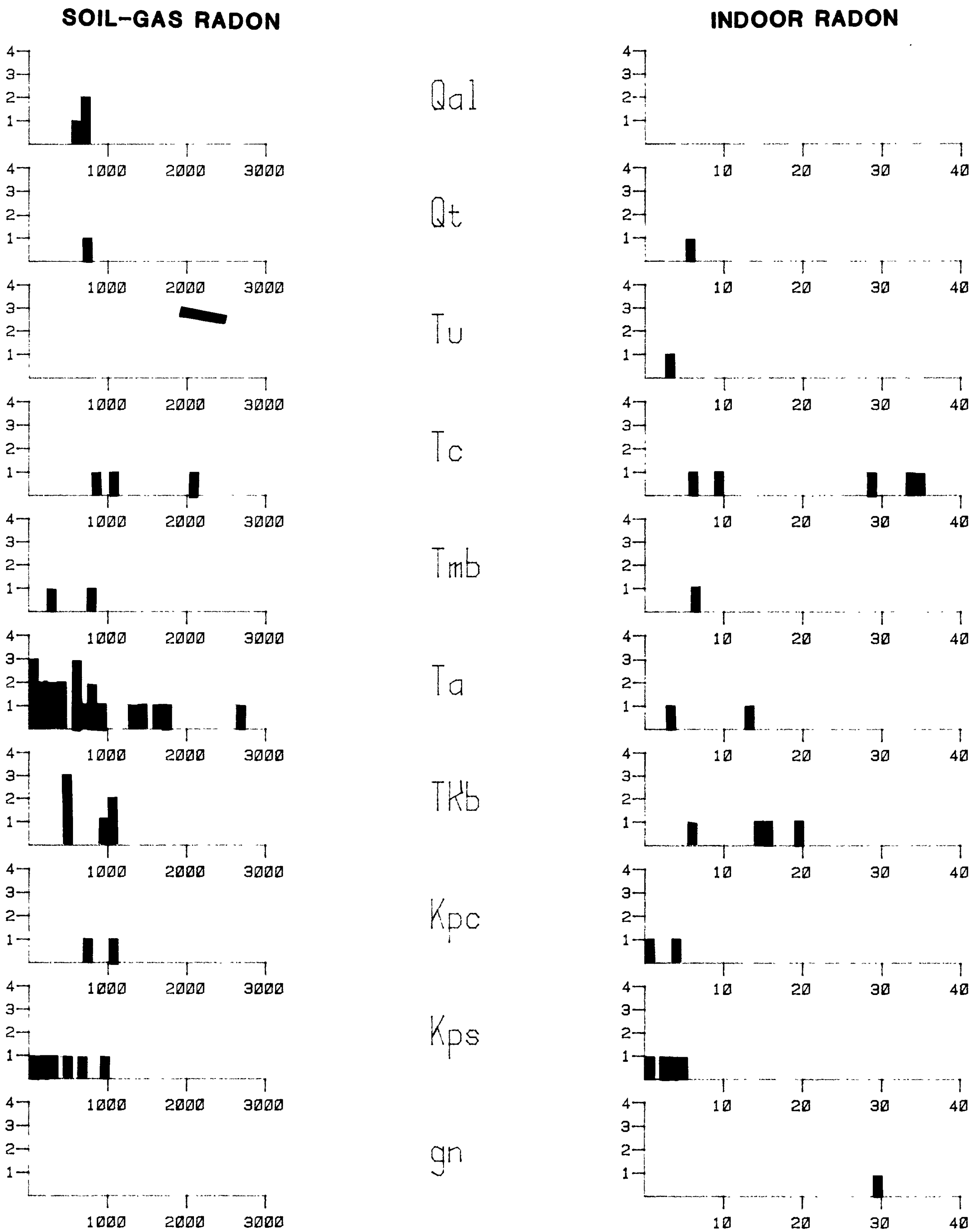
U. S. Environmental Protection Agency, 1986, A citizen's guide to radon: OPA-86-004, 13 p.

Figure Captions

Figure 1. Location of radon soil-gas samples on a geologic map of Prince Georges County, Maryland (after Hack, 1977).

Figure 2. Frequency histograms of the radon distribution plotted by individual formation. The radon concentrations are in pCi/L.

Figure 3. Frequency histograms of radon concentrations for individual formation ages sampled during this study. The radon concentrations are in pCi/L.


SOIL-GAS RADON
INDOOR RADON
Qal
Qt
Tu
Tc
Tmb
Ta
TKb
Kpc
Kps
gn
1
2
3
4
1000
2000
3000
10
20
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40

FIGURE 2.

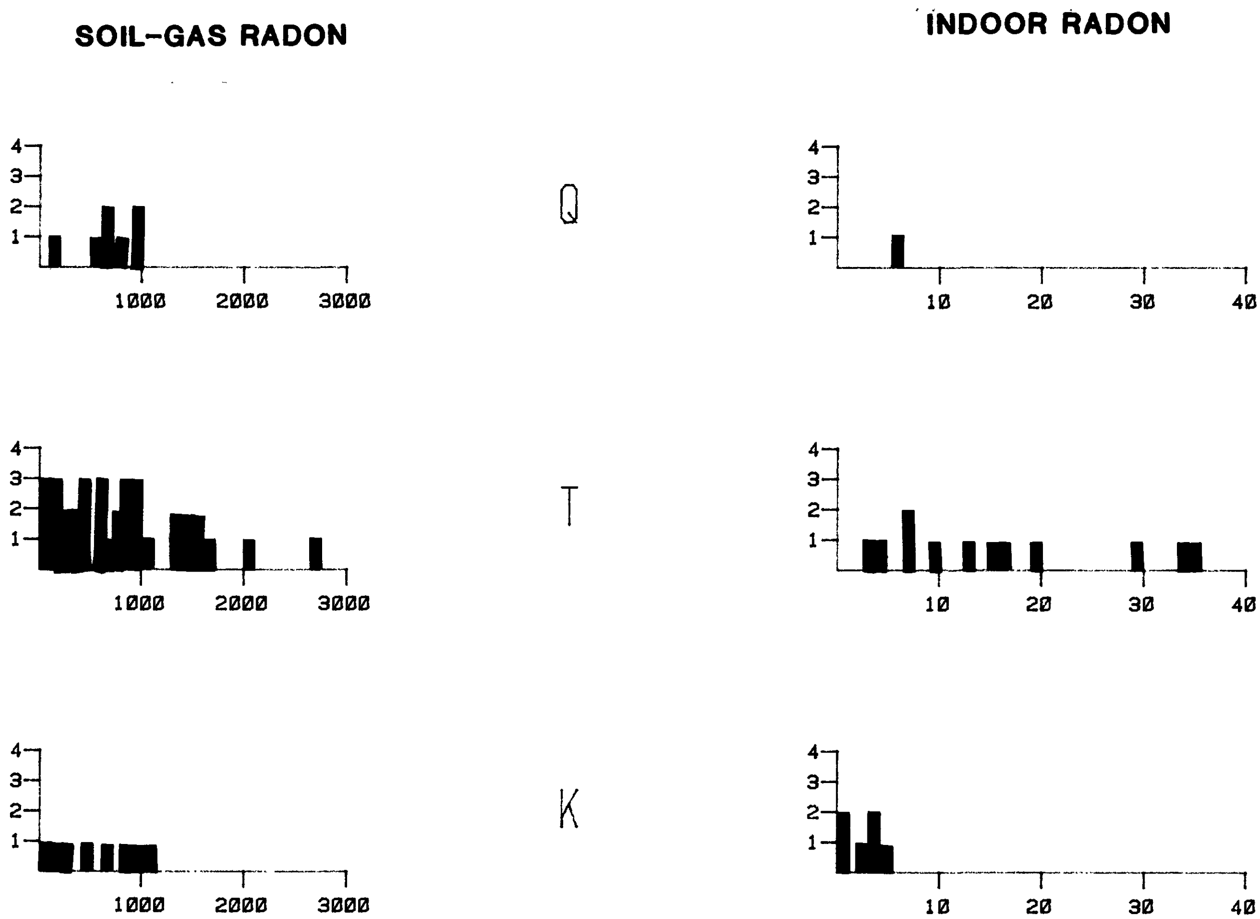
SOIL-GAS RADON
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FIGURE 3.

STRATIGRAPHIC SEQUENCE

Qal	River Alluvium
Qt	River Terrace Deposits
Tu	Upland Deposits
Tc	Chesapeake Group
Tn	Nanjemoy Formation, Upper Member
Tmb	Nanjemoy Formation, Marlboro Clay Member
Ta	Aquia Formation
Tkb	Brightseat Formation
Kpc	Potomac Group, red and white clay
Kps	Potomac Group, sandy clay and gravel
Kp	Potomac Group, undifferentiated materials
gn	Gneiss and Schist

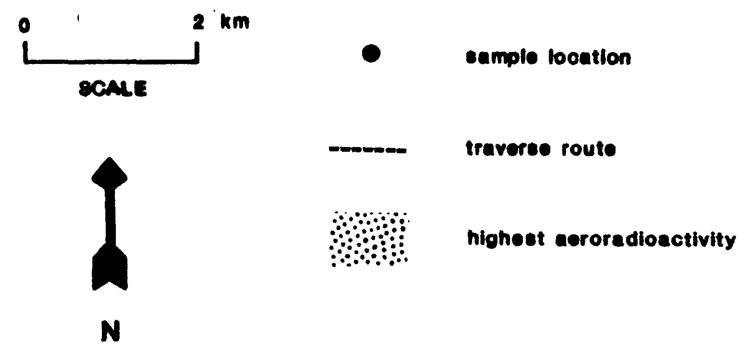

FIGURE 1.

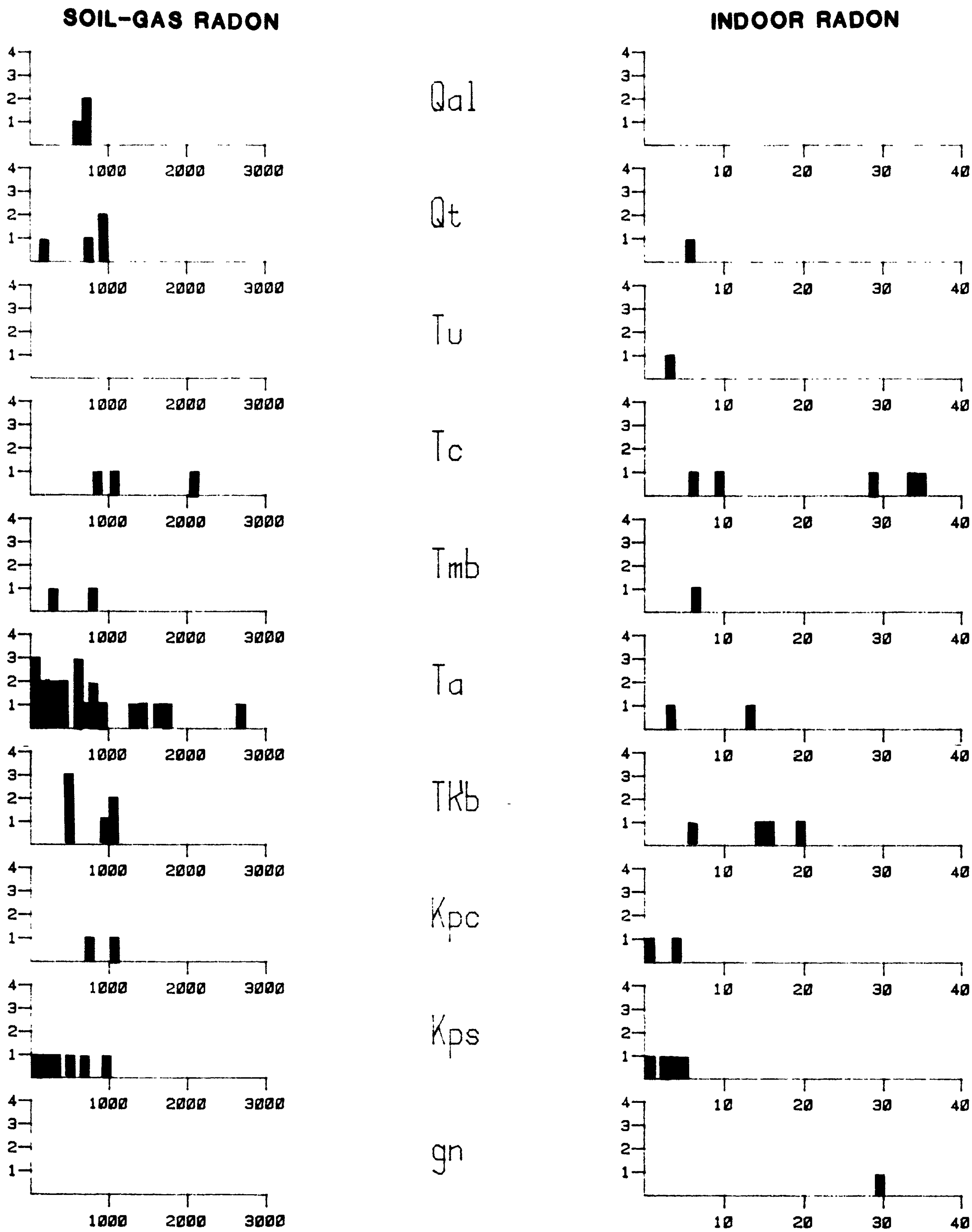
SOIL-GAS RADON
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FIGURE 2.