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RADON AVAILABILITY IN NEW MEXICO

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Introduction

Radon is a radioactive, colorless, odorless, and tasteless gas that is naturally occurring in our environment. It is a short-lived radioactive decay product of radium which is in turn a radioactive decay product of uranium (figures 1 and 2). The radon gas decays into a series of radioactive daughter products (Figure 1) to which most of the health risks are attributed. Exposure to elevated concentrations of radon over long periods of time may increase chances of developing lung cancer.

Radon is not a problem outdoors because the atmosphere dilutes the gas and associated health risks. However, radon becomes an indoor hazard when the gas leaks from the ground (Figure 3) beneath a house into the house through cracks in the foundations and floors and around pipes and joints. Most of the radon generated from trace amounts of uranium in mineral and rock grains in a soil or rock remains within the grain (Figure 3). Only 10–50 percent of the radon generated escapes the mineral grain and enters pore spaces where it migrates through the pore spaces and cracks toward the surface (figures 3 and 4; Otton 1992). Radon also becomes dissolved in water as the water moves through rocks and soils containing uranium. Water then may become a source for indoor radon. Radon becomes concentrated in the house, especially in colder months when the house is closed. The gas decays to the solid radioactive particles (Figure 1) that adhere to dust particles, furniture, walls and floors and tends to remain in the house until it is breathed into the lungs. The health risks increase in areas of poor ventilation, such as basements, where the heavy gas tends to accumulate.

As a result of the perceived health risks associated with radon, numerous state and federal agencies have interacted and are conducting studies to evaluate the levels of indoor radon and radon in groundwater in New Mexico and elsewhere in the

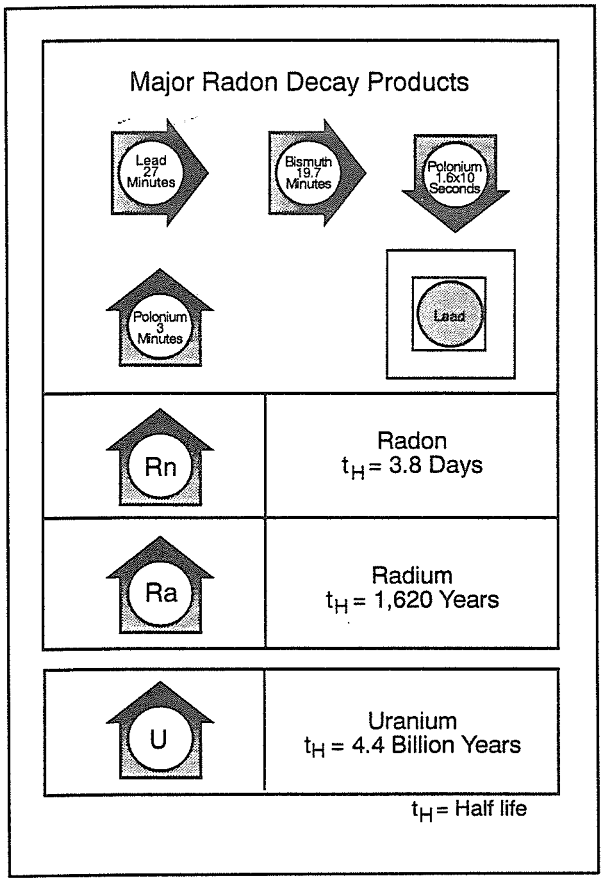

Figure 1. Major radon decay products (Otton 1992). Radon is a naturally occurring gas that is produced by the radioactive decay of uranium and radium.

United States (Magno and Guimond 1987; Brookins 1986, 1988; McLemore and Hawley 1988; Manchego et al. 1991; McLemore et al. 1991; Dubiel 1993; Berge 1994). The New Mexico Bureau of Mines and Mineral Resources (NMBMMR) in cooperation with the Radiation Licensing and Registration Section of the New Mexico Environment Department (NMED) and the U.S. Environmental Protection Agency (EPA) have been evaluating geologic and soil conditions that may contribute to elevated levels of indoor radon throughout New Mexico. Various data have been integrated and interpreted in order to determine areas of high radon availability. The purpose of this paper is to summarize some of these data for New Mexico and to discuss geologic controls on the distribution of radon. Areas in New Mexico have been identified from these data as having a high radon availability. It is not the intent of this report to alarm the public, but to provide data on the distribution of radon throughout New Mexico. Discussions of the perceived health risks are beyond the scope of this report and the expertise of this author. Furthermore, it is extremely difficult to predict for an individual house if indoor radon may be a hazard. The only way to determine the levels of indoor radon in a specific house is to test that house for radon.

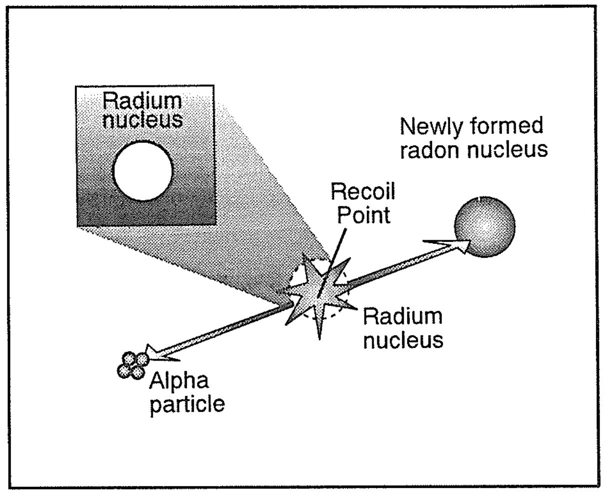

Figure 2. Formation of radon occurs by the natural decay of radium. A radium atom releases an alpha particle that contain two neutrons and two protons which results in radon (Otton 1992).

Geologic Factors

Radon is a naturally occurring element that occurs everywhere, but the concentration of radon is dependent upon the concentration of uranium in the soil, rock, and water and the permeability of the soil and rock. Uranium is found in trace amounts in all soils and rocks. However, in New Mexico many of the soils and rocks naturally contain elevated levels of uranium as compared to the average crustal abundance (Table 1). These rocks weather to form soils which contain elevated levels of uranium that may generate elevated levels of radon.

Several scientific methods are available to determine the concentrations of uranium in a material. The material can be sampled and assayed for total amount of uranium (Table 1). Scientific instruments also are available that can measure the radioactivity and can be calibrated to provide a measure of equivalent uranium which is related to total uranium. Some of the specialized instruments can be placed in an airplane or helicopter which can then cover a much larger area than direct sampling.

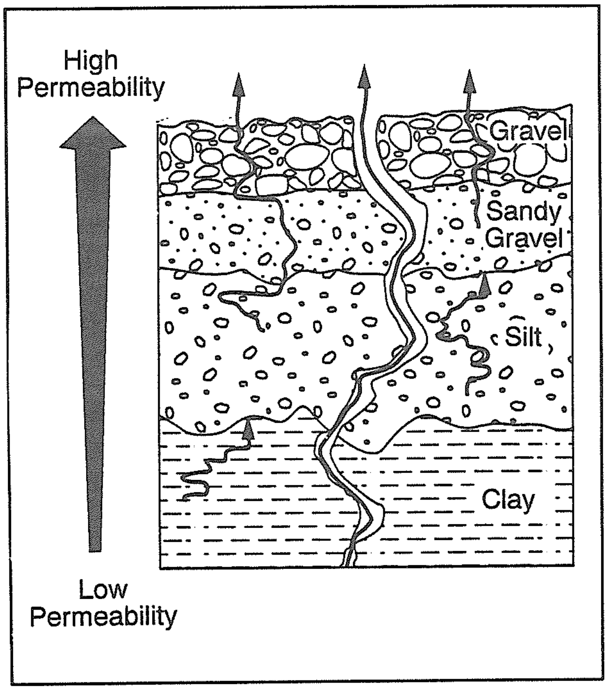

Figure 3. Mobility of radon in the subsurface. Radon can travel through cracks in rocks and soils and through pore spaces (Otton 1992).

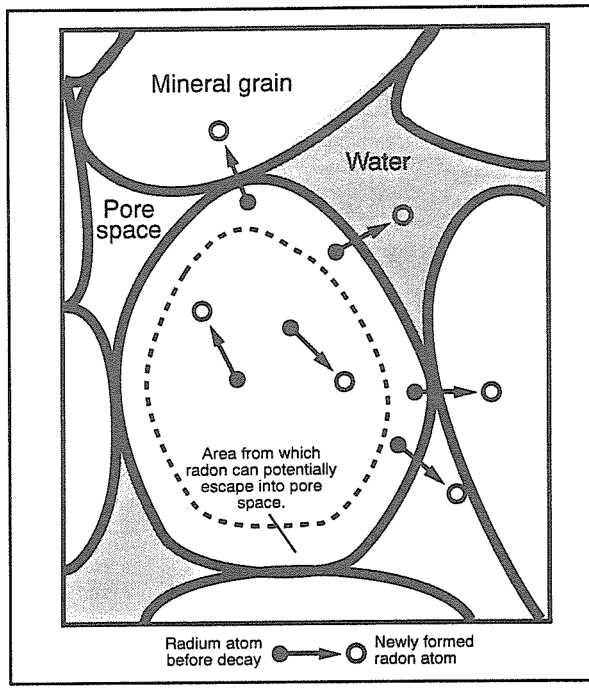

Figure 4. Movement of radon within a soil or rock. Most of the radon remains in the mineral grain, only 10 to 50 percent escapes to enter the pore space (Otton 1992).

Aerial radiometric data provide a regional estimate of uranium concentrations in the surficial rocks and soils and correlates well with the amount of radon in the ground (Duval 1988; McLemore and Hawley 1988; McLemore et al. 1991). The primary source for aerial radiometric data in New Mexico is a series of reports prepared as part of the National Uranium Resource Evaluation (NURE) program (McLemore and Chamberlin 1986). A colored contour map of New Mexico showing radiometric equivalent uranium (eU) concentrations was prepared by the U.S. Geological Survey at a scale of 1:1,000,000 from the computerized aerial radiometric data. A copy of this map is available for inspection at the NMBMMR.

Areas in New Mexico that exceed 5 ppm eU from the NURE aerial radiometric data are shown in Figure 5. The extremely high uranium anomalies in the aerial radiometric data (>5 ppm eU) near Grants in Cibola County are a result of high values measured over uranium mill tailings. The computer generated map exaggerates the significance of these anomalies; the actual area affected by the mill tailings is small and probably has not contributed excessive indoor radon to nearby houses. Most of these mill tailings are being reclaimed.

Other areas in New Mexico with high equivalent uranium (Figure 5) are related to known uranium occurrences (i.e., Gallup, Vermejo Park, Laughlin Peak) or to areas containing rocks that are known to be elevated in uranium concentrations (i.e., northern McKinley County, Gallup, southern Socorro County, Las Cruces, Cornudas Mountains). The aerial radiometric data are discussed in more detail by McLemore and Hawley (1988). Areas that contain known uranium occurrences, prospects, or mines also may also generate high levels of radon. Most of the uranium mined in New Mexico came from underground and open pit mines in the Grants-Gallup area known as the Grants uranium district (Chenoweth 1976; McLemore 1983a; McLemore and Chenoweth 1989).

Highly permeable soils in an area may concentrate radon and can contribute to elevated indoor radon levels. Soils that are well-drained or dry most of the year and soils that form deep cracks allow migration of radon from the subsurface to the surface (Figure 3) and possibly into a house. Thin soils that barely cover uranium-bearing rocks also tend to allow migration of radon, especially if the underlying rocks are fractured. Elevated levels of radon have been found in areas over limestones or other

TABLE 1. URANIUM CONCENTRATIONS IN SELECTED ROCK TYPES IN NEW MEXICO

Rock Type	Location	U ppm	Reference
Average Precambrian rock	New Mexico	3.7	Condie and Brookins (1980)
Average Sandia Granite (31 samples)	Albuquerque	4.7	Brookins (1988)
Average Madera Limestone (19 samples)	Albuquerque	5.7	Brookins (1988)
Average metamorphic rocks (9 samples)	Sandia Mountains	4.8	Brookins (1988)
Soil samples (51 samples)	Albuquerque	4.7	Brookins (1988)
Volcanic rocks	Mogollon-Datil volcanic field	2.3-5.2	Bornhorst and Elston (1981)
Precambrian granitic rocks	Caballo Mountains	3-2329	McLemore (1986)
Precambrian granite	east of Socorro (Tajo granite)	5.9-161	McLemore (1983b)
Tertiary nepheline syenite	Cornudas Mountains, Otero County	3-25	McLemore and Guilinger (1993)
Tertiary granite	Capitan Mountains, Lincoln County	2-6	Allen and McLemore (1991)
Precambrian anorthosite, gneiss, and granite	Burro Mountains, Grant County	2-43	McLemore and McKee (1988a, b)
Precambrian metarhyolite and tonalite	Nacimiento Mountains	0.9-5	Brookins and Della Valle (1977)
Precambrian granite	Manzano and Los Piños Mountains	0.7-8	Brookins and Della Valle (1977)
Precambrian granite and syenite	Florida Mountains, Luna County	1-8	Brookins and Della Valle (1977)
Jurassic sandstones and shales, Morrison Formation	McKinley and Cibola counties	3-9	Brookins and Della Valle (1977)
Average crustal abundance	---	2.7	Krauskopf (1979)
Average granite	---	5.0	Krauskopf (1979)
Average basalt	---	0.5	Krauskopf (1979)
Average shale	---	3.5	Krauskopf (1979)

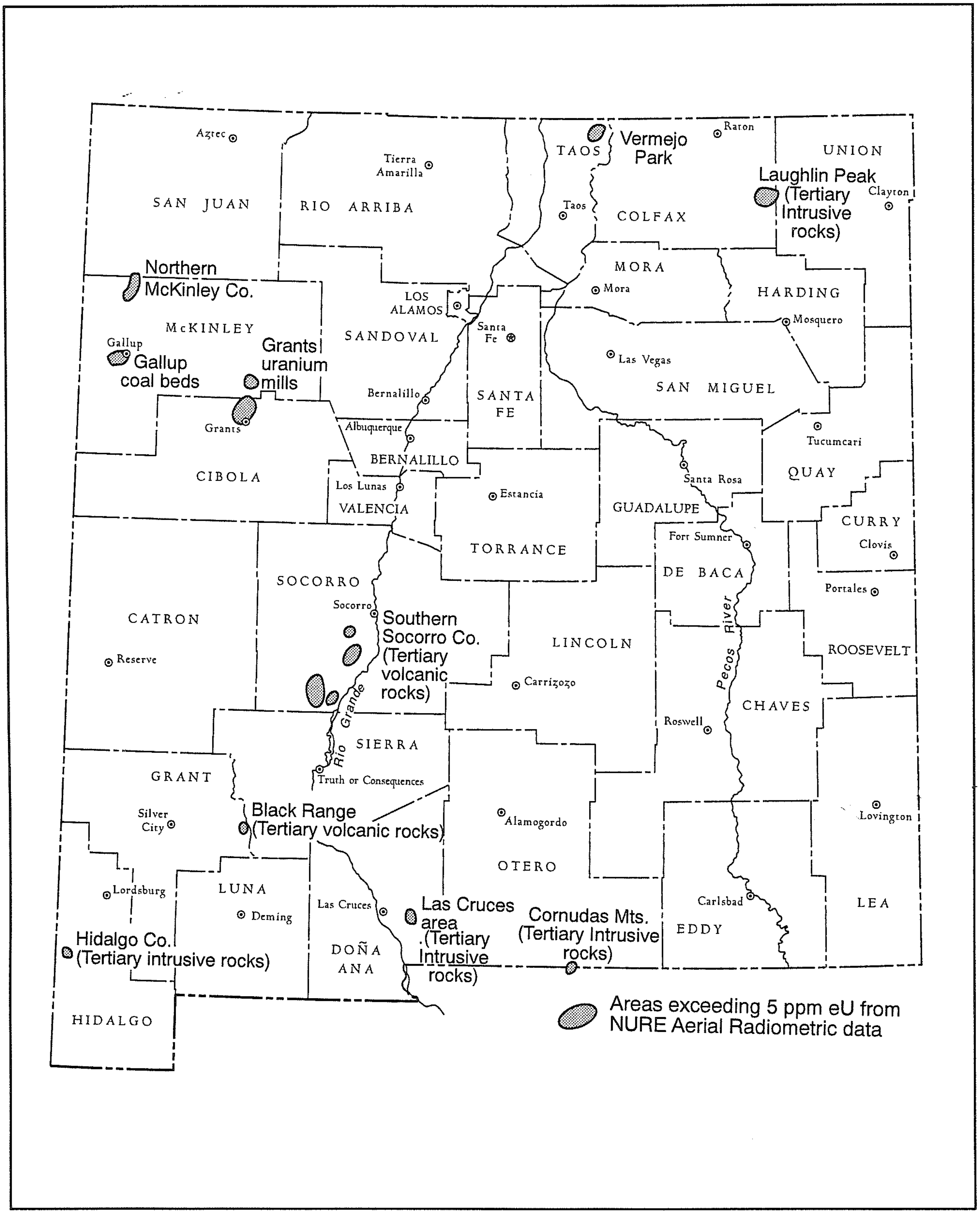

Figure 5. Areas with elevated uranium concentrations exceeding 5 ppm eU from NURE aerial radiometic data (McLemore and Hawley 1988).

carbonate rocks that tend to have large caves or caverns that can contribute to migration of radon.

Indoor Radon Survey

Indoor radon measurements were made with charcoal canisters supplied by the EPA and distributed by NMED. Measurements were made under closed-house conditions in the lowest liveable area of the house. Additional details concerning the indoor radon survey are by McLemore et al. (1991) and Manchego et al. (1991).

Average indoor radon levels by county in New Mexico are summarized in Table 2 and Figure 6. Average indoor radon levels in Albuquerque are summarized in Table 3 and Figure 7. Histograms of the data are in figures 8, 9, and 10.

Radon in Groundwater

The New Mexico Scientific Laboratory Division of the Department of Health and the City of Albuquerque have been systematically analyzing groundwater samples throughout New Mexico for radon (Berge 1994). Summary of these data are in tables 4, 5, and 6 and in figures 11 and 12.

Discussion

Available geologic, soil, indoor radon, and groundwater radon data were integrated and interpreted to identify geologic controls of radon concentrations and to identify areas of high radon-availability. Radon-availability categories are relative to each other and specific to New Mexico. Because the risk of inhaling or ingesting a dangerous amount of radon is due to complex architecture, atmospheric, and geologic factors, we refrain from using the term "risk" in evaluating areas for availability of radon. The actual health risks for each availability category are not known; more research is needed. More specific details on each category are by McLemore and Hawley (1988) and McLemore et al. (1991).

The EPA's nationwide survey of indoor radon levels in houses required that each county be ranked for radon availability. Preliminary rankings were by McLemore and Hawley (1988) and revised by Dubiel (1993). Revised rankings, as determined in this report, are in Table 7 and Figure 13. A revised ranking for the largest cities in New Mexico is in Table 8.

However, New Mexico is the fifth-largest state in the United States, but it contains only 33 counties. The geology and terrain of New Mexico are quite diverse and major geologic terrains cut across most county boundaries, creating obvious problems in ranking counties for radon-availability. Therefore, it is logical to examine the entire state and rank by geologic terrain (McLemore and Hawley 1988). A preliminary classification of radon-availability by geologic terrain is in Figure 14 and briefly summarized in Table 9.

Five geologic terrains in New Mexico are identified as having a high radon-availability (Table 9, Figure 14). These areas consist of rocks which typically exceed 2.7 ppm eU on the aerial radiometric map (Figure 5) and generally, but not always, include well-drained, permeable, dry soils. This category includes areas of Precambrian outcrops of granitic rocks that contain elevated uranium concentrations of 3-2329 ppm (Table 1). Tertiary rhyolitic and andesitic volcanic rocks in southwestern New Mexico also contain anomalously high concentrations of uranium in local areas (Table 1; Walton et al. 1980; Bornhorst and Elston 1981). For example, a sample of the Alum Mountain andesite near Silver City, Grant County, contained 35.1 ppm eU (Bornhorst and Elston 1981). Many uranium occurrences, prospects, and mines are found in these uraniferous areas. Most such areas have some houses that when tested exceed 10 pCi/L (Table 2). Groundwater samples in these areas are variable with concentrations exceeding 300 pCi/L (Table 5, Figure 11).

Eight geologic terrains in New Mexico are identified as having a moderate radon-availability (Table 9, Figure 14). These areas include rocks with 2.3-2.7 ppm eU on the aerial radiometric map and generally consist of moderately permeable soils. This category includes many outcrop areas of Precambrian metamorphic rocks, Paleozoic and Mesozoic sedimentary rocks, and Tertiary-Quaternary sedimentary rocks. Indoor radon levels are variable, but a few houses tested exceed 10 pCi/L (Table 2, Figure 6). Groundwater samples in these areas are variable with many concentrations exceeding 300 pCi/L (Table 5, Figure 11). Although the Albuquerque area is rated as moderate, areas near the Sandia Mountains and along the Rio Grande have a high radon availability (Table 8, figures 10 and 12).

TABLE 2. AVERAGE INDOOR RADON LEVELS BY COUNTY IN NEW MEXICO (MANCHEGO ET AL. 1991). INDOOR RADON LEVELS DETERMINED BY MEASUREMENT OF CHARCOAL CANISTERS SUPPLIED BY THE EPA. AREA SHOWN IN FIGURE 6

County	<4 pCi/L		>4<10 pCi/L		>10<20 pCi/L		>20 pCi/L		Total number of homes tested
	no.	%	no.	%	no.	%	no.	%	
Bernalillo	267	70.6	85	22.5	22	5.8	4	1.1	378
Catron	16	94.1	1	5.9	0	0.0	0	0.0	17
Chaves	41	82.0	9	18.0	0	0.0	0	0.0	50
Cibola	8	53.3	7	46.7	0	0.0	0	0.0	15
Colfax	43	51.2	31	36.9	8	9.5	2	2.4	84
Curry	35	83.3	6	14.3	1	2.4	0	0.0	42
De Baca	12	92.3	1	7.7	0	0.0	0	0.0	13
Doña Ana	75	92.6	6	7.4	0	0.0	0	0.0	81
Eddy	39	81.3	9	18.8	0	0.0	0	0.0	48
Grant	48	87.3	6	10.9	1	1.8	0	0.0	55
Guadalupe	6	100.0	0	0.0	0	0.0	0	0.0	6
Harding	9	90.0	1	10.0	0	0.0	0	0.0	10
Hidalgo	8	53.3	6	40.0	1	6.7	0	0.0	15
Lea	47	94.0	3	6.0	0	0.0	0	0.0	50
Lincoln	16	94.1	1	5.9	0	0.0	0	0.0	17
Los Alamos	30	76.9	8	20.5	1	2.6	0	0.0	39
Luna	35	70.0	12	24.0	2	4.0	1	2.0	50
McKinley	29	63.0	15	32.6	1	2.2	1	2.2	46
Mora	11	61.1	6	33.3	1	5.6	0	0.0	18
Otero	35	79.5	8	18.2	0	0.0	1	2.3	44
Quay	5	55.6	4	44.4	0	0.0	0	0.0	9
Rio Arriba	55	78.6	9	12.9	5	7.1	1	1.4	70
Roosevelt	36	90.0	4	10.0	0	0.0	0	0.0	40
Sandoval	55	78.6	7	10.0	6	8.6	2	2.9	70
San Juan	158	88.3	20	11.2	0	0.0	1	0.6	179
San Miguel	34	54.0	22	34.9	4	6.3	3	4.8	63
Santa Fe	40	54.1	28	37.8	5	6.8	1	1.4	74
Sierra	39	100.0	0	0.0	0	0.0	0	0.0	39
Socorro	30	81.1	7	18.9	0	0.0	0	0.0	37
Taos	19	40.4	20	42.6	5	10.6	3	6.4	47
Torrance	7	58.3	5	41.7	0	0.0	0	0.0	12
Union	18	66.7	8	29.6	1	3.7	0	0.0	27
Valencia	27	100.0	0	0.0	0	0.0	0	0.0	27

Note: This data is provided only for informational purposes. The only way to determine the levels of indoor radon in a specific house is to test that house for radon.

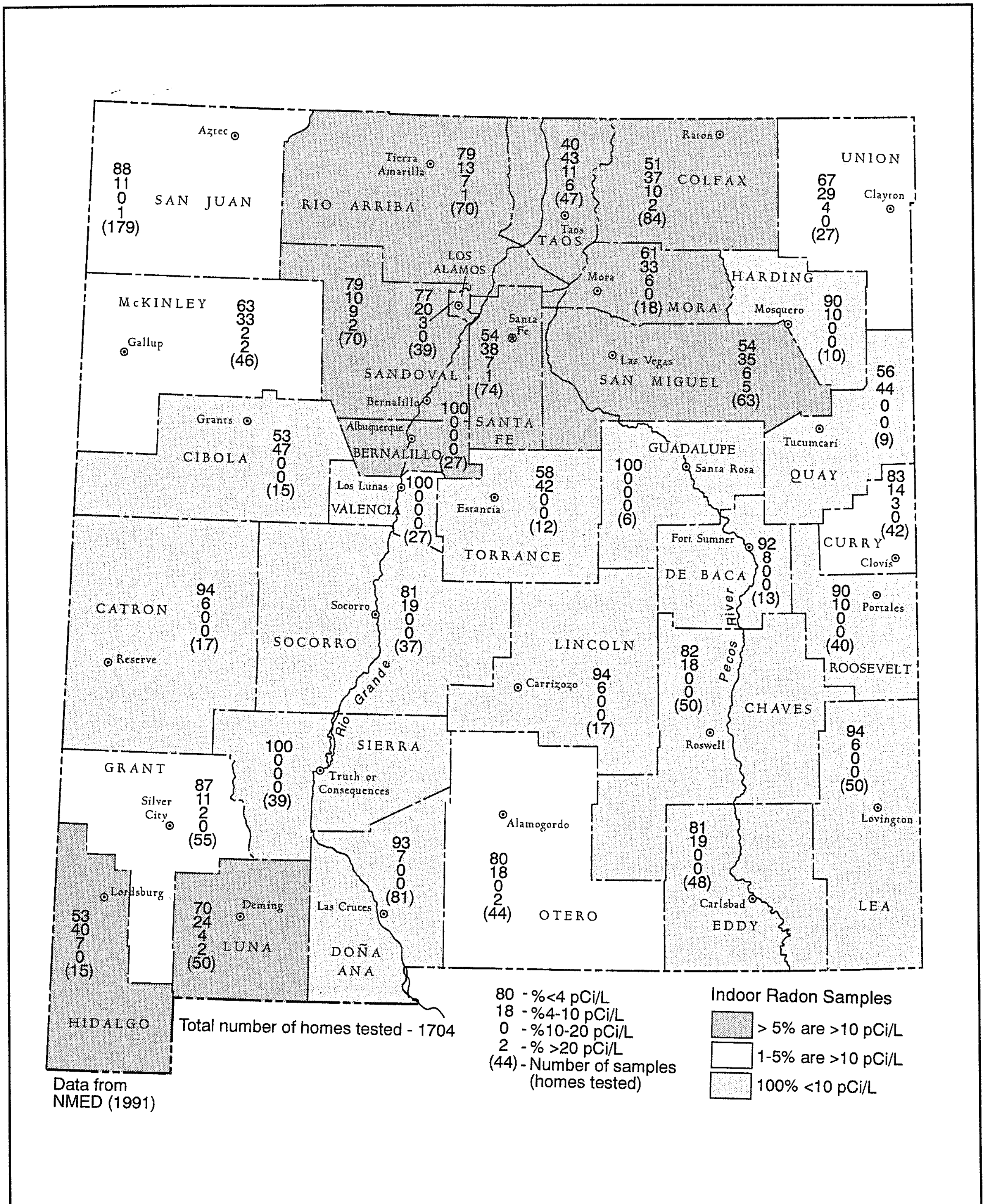

Figure 6. Indoor radon survey 1987-1989. Data from Manchego et al. (1991). Data in Table 2.

TABLE 3. AVERAGE INDOOR RADON LEVELS IN ALBUQUERQUE AREA BY ZIP CODE (MANCHEGO ET AL. 1991). INDOOR RADON LEVELS DETERMINED BY MEASUREMENTS OF CHARCOAL CANISTERS SUPPLIED BY THE EPA. AREAS SHOWN IN FIGURE 7

Zip Code	<4 pCi/L		>4<10 pCi/L		>10<20 pCi/L		>20 pCi/L		Total no. of homes tested
	no.	%	no.	%	no.	%	no.	%	
87122	2	25.0	2	25.0	2	25.0	2	25.0	8
87111	35	56.5	17	27.4	9	14.5	1	1.6	62
87112	27	62.8	14	32.6	2	4.7	0	0.0	43
87123	16	80.0	3	15.0	0	0.0	1	5.0	20
87108	17	85.0	3	15.0	0	0.0	0	0.0	20
87110	34	73.9	12	26.1	0	0.0	0	0.0	46
87109	14	51.9	9	33.3	4	14.8	0	0.0	27
87113	1	33.3	2	66.7	0	0.0	0	0.0	3
87114	7	87.5	1	12.5	0	0.0	0	0.0	8
87048	10	76.9	2	15.4	1	7.7	0	0.0	13
87107	22	73.3	6	20.0	2	6.7	0	0.0	30
87104	10	83.3	1	8.3	1	8.3	0	0.0	12
87102	3	60.0	1	20.0	1	20.0	0	0.0	5
87106	19	95.0	1	5.0	0	0.0	0	0.0	20
87105	32	88.9	4	11.1	0	0.0	0	0.0	36
TOTAL	249	70.5	78	22.2	22	6.2	4	1.1	353

Note: This data is provided only for informational purposes. The only way to determine the levels of indoor radon in a specific house is to test that house for radon.

The remainder of the state is classified as low radon-availability. Most of these areas have rocks with less than 2.3 ppm eU on the aerial radiometric map. Indoor radon levels rarely exceed 10 pCi/L (Table 2), but high indoor radon levels do occur locally. Groundwater samples in these areas are variable with some concentrations exceeding 300 pCi/L (Table 5).

It should be emphasized that even in counties with moderate and high radon availability potential, many houses have low indoor radon levels. Conversely, some houses in areas with low radon-availability may still have elevated levels of indoor radon. There may be no obvious geologic reasons for predicting their existence in low radon-availability areas.

Conclusions

- More research is needed on indoor radon levels and concentrations of radon in groundwater and soils in New Mexico.
- Radon levels indoors and in groundwaters are related to concentrations of uranium and radium in soils and rocks.
- Five geologic terrains in New Mexico are identified as having a high radon-availability: southern Rocky Mountains, Grants uranium district, Jemez and Tusas Mountains, Sandia-Manzano-Los Piños Mountains, and southwest New Mexico (Hidalgo and Luna counties) (Table 9, Figure 14). Eight geologic terrains in New Mexico are identified as having a moderate radon-availability: Colorado Plateau, Mogollon-Datil volcanic province, Organ-San Andres Mountains, Lincoln County, east-central New Mexico (San Miguel County), Laughlin Peak, and eastern New Mexico (Table 9, Figure 14). Many houses in high radon-availability areas have radon below 4 pCi/L, but locally, houses in low radon-availability areas have radon levels that exceed 4 pCi/L. The only way to determine the

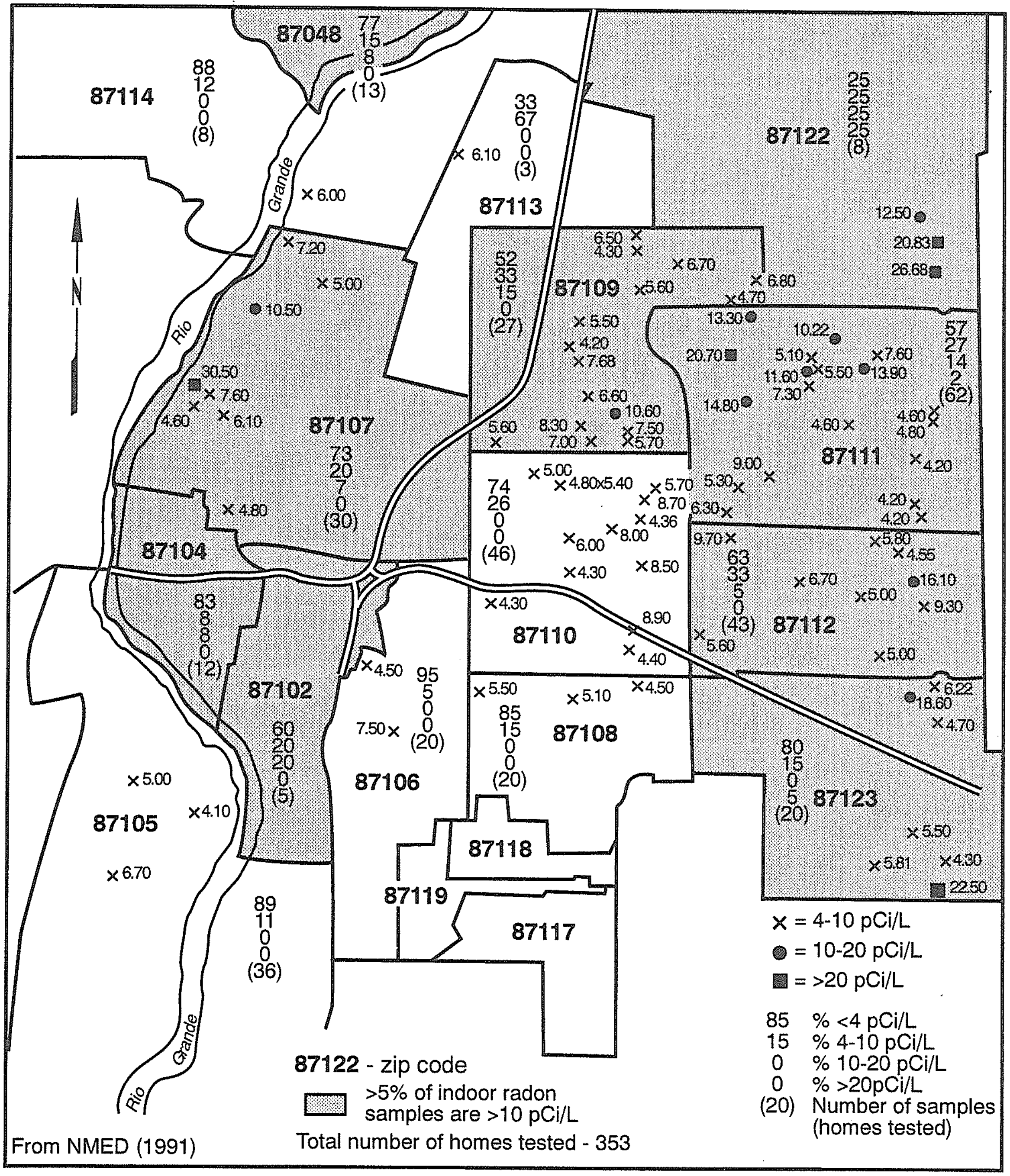

Figure 7. Selected indoor radon levels in the Albuquerque area (Manchego et al. 1991). Data in Table 3.

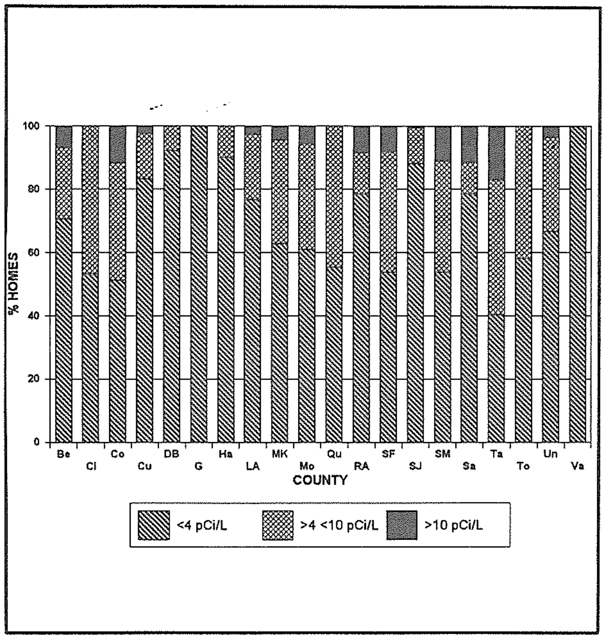

Figure 8. Histogram of indoor radon levels, by county, in northern New Mexico. Be-Bernalillo, Ci-Cibola, Co-Colfax, Cu-Curry, DB-De Baca, G-Guadalupe, Ha-Harding, LA-Los Alamos, MK-McKinley, Mo-Mora, Qu-Quay, RA-Rio Arriba, SF-Santa Fe, SJ-San Juan, SM-San Miguel, Sa-Sandoval, Ta-Taos, To-Torrance, Un-Union, Va-Valencia (data from Manchego et al. 1991).

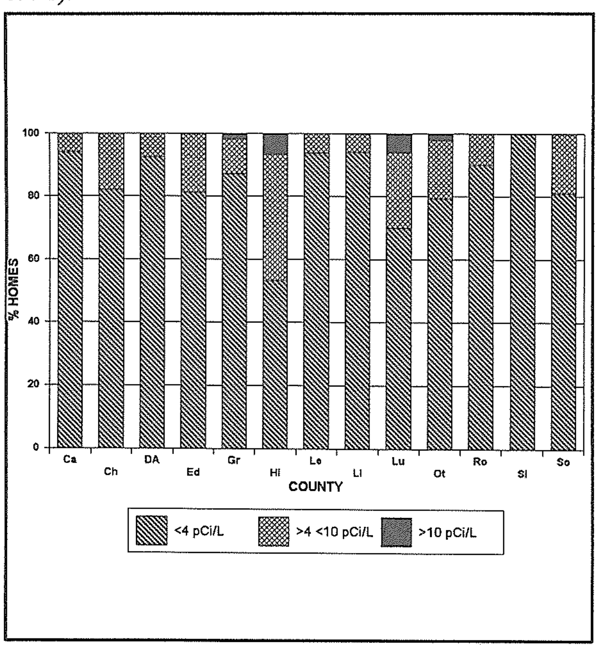

Figure 9. Histogram of indoor radon levels, by county, in southern New Mexico. Ca-Catron, Ch-Chaves, DA-Doña Ana, Ed-Eddy, Gr-Grant, Hi-Hidalgo, Le-Lea, Li-Lincoln, Lu-Luna, Ot-Otero, Ro-Roosevelt, Si-Sierra, So-Socorro (data from Manchego et al. 1991).

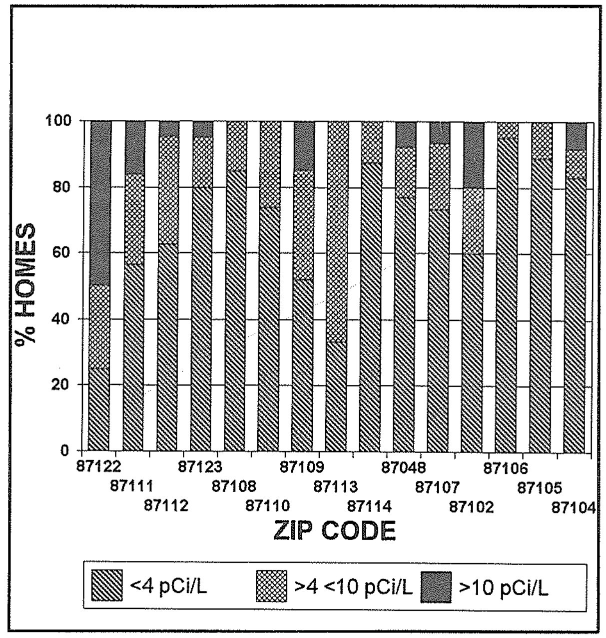

Figure 10. Histogram of indoor radon levels by zip code in the Albuquerque area (data from Manchego et al. 1991).

levels of indoor radon in a specific house is to test that house for radon.

- Five of the largest cities have a high radon-availability: Santa Fe, Gallup, Las Vegas, Deming, and Taos (Table 8).
- Areas in Albuquerque with a high radon-availability include areas adjacent to the Sandia Mountains and along the Rio Grande (figures 10 and 12, Table 3).
- Areas with low levels of radon-availability may have high levels of radon in groundwater (Figure 11). Most groundwaters sampled from throughout New Mexico have radon concentrations exceeding 100 pCi/L (95.9% of samples, Berge 1994). Sixty-eight percent of groundwaters tested have radon concentrations exceeding 300 pCi/L (Berge 1994).
- These results suggest that additional studies on background concentrations of uranium, radium, and radon must be performed before federal standards can be imposed. Many areas in New Mexico naturally exceed proposed standards.

Acknowledgments

Discussions with Jacques Renault, Richard Chamberlin, George Austin, Frank Kottlowski, Charles Chapin, and John Hawley were appreciated. Richard Chamberlin provided the NURE geochemical data at a scale of 1:1,000,000. John Hawley provided soil permeability data. Ralph Manchego of the New Mexico Environment Department provided the indoor radon data. Loren A. Berge (New Mexico Department of Health) and Norm Gaume and Barbara Gastian (City of Albuquerque, Public Works Department) provided data on radon in groundwater.

TABLE 4. SUMMARY OF FREQUENCY DISTRIBUTION OF RADON CONCENTRATIONS IN GROUNDWATER COLLECTED AT THE WELL HEAD BY DISTRICT (DEFINED BY NM DEPT OF HEALTH) (BERGE 1994)

State Wide	
No. of samples	704 samples
% > 50 pCi/L	97.4%
% > 100 pCi/L	95.9%
% > 200 pCi/L	84.0%
% > 300 pCi/L	68.0%
% > 600 pCi/L	39.0%
% >1000 pCi/L	20.0%
% >2000 pCi/L	4.3%
% >3000 pCi/L	2.0%
% >5000 pCi/L	0.7%
Highest Value	7790.0 pCi/L
District #1 (Albuquerque)	
No. of samples	141 samples
% > 50 pCi/L	97.9%
% > 100 pCi/L	95.7%
% > 200 pCi/L	82.0%
% > 300 pCi/L	52.0%
% > 600 pCi/L	23.0%
% >1000 pCi/L	11.0%
% >2000 pCi/L	2.8%
% >3000 pCi/L	1.4%
% >5000 pCi/L	0.0%
Highest Value	3750.0 pCi/L

TABLE 4 (CONTINUED)

District #2 (Santa Fe)	
No. of samples	160 samples
% > 50 pCi/L	97.5%
% > 100 pCi/L	96.9%
% > 200 pCi/L	93.0%
% > 300 pCi/L	88.0%
% > 600 pCi/L	56.0%
% >1000 pCi/L	32.0%
% >2000 pCi/L	7.5%
% >3000 pCi/L	5.6%
% >5000 pCi/L	1.9%
Highest Value	7730.0 pCi/L
District #3 (Las Cruces)	
No. of samples	257 samples
% > 50 pCi/L	97.3%
% > 100 pCi/L	96.1%
% > 200 pCi/L	86.1%
% > 300 pCi/L	75.0%
% > 600 pCi/L	44.0%
% >1000 pCi/L	21.0%
% >2000 pCi/L	3.1%
% >3000 pCi/L	0.4%
% >5000 pCi/L	0.0%
Highest Value	4330.0 pCi/L
District #4 (Roswell)	
No. of samples	146 samples
% > 50 pCi/L	97.3%
% > 100 pCi/L	94.5%
% > 200 pCi/L	70.0%
% > 300 pCi/L	49.0%
% > 600 pCi/L	27.0%
% >1000 pCi/L	13.0%
% >2000 pCi/L	4.1%
% >3000 pCi/L	1.4%
% >5000 pCi/L	1.4%
Highest Value	7790.0 pCi/L

TABLE 5. RADON CONCENTRATIONS IN GROUNDWATER COLLECTED AT THE WELL HEAD BY FIELD OFFICE AREAS (BERGE 1994)

Field Office Area	Number of samples	Average (pCi/L)	Minimum (pCi/L)	Maximum (pCi/L)
District #1:				
Albuquerque	19	667	97	3747
Bernalillo	24	346	109	997
Farmington	3	323	140	549
Gallup	49	484	21	2740
Grants	18	596	12	2430
Los Lunas	28	616	16	3410
District #2:				
Santa Fe	48	861	4	3814
Española	61	780	-9	7730
Las Vegas	17	1056	85	5160
Raton	16	828	146	4440
Taos	18	2122	468	6880
District #3:				
Las Cruces	162	801	39	4330
Alamogordo	57	330	-2	922
Deming	18	602	102	2820
Silver City	20	753	195	1240
District #4:				
Roswell	8	232	52	468
Carlsbad	15	175	105	251
Clovis	45	646	34	5280
Hobbs	25	228	21	1170
Ruidoso	17	743	99	1995
Tucumcari	36	881	40	7790

Note: Samples were collected by personnel from each field office (as defined by the New Mexico Department of Health) from throughout their respective areas.

TABLE 6. SUMMARY OF RADON LEVELS IN GROUNDWATER IN THE ALBUQUERQUE AREA. ANALYSES BY THE SCIENTIFIC LABORATORY DIVISION OF THE NEW MEXICO DEPARTMENT OF HEALTH (DATA FROM CITY OF ALBUQUERQUE, PUBLIC WORKS DEPARTMENT)

	1st quarter 1993	2nd quarter 1993	3rd quarter 1993	4th quarter 1993	2nd quarter 1994	Average
Maximum	1970	2020	1820	2010	2110	2110
Mean	482	482	464	480	455	473
Minimum	71	81	123	102	150	71
92 wells sampled						

TABLE 7. RADON-AVAILABILITY RATING FOR COUNTIES IN NEW MEXICO 1994

High	% homes tested >10 pCi/L	Moderate	% homes tested >10 pCi/L	Low	% homes tested >10 pCi/L
Rio Arriba	8.5	San Juan	0.6	Valencia	0.0
Sandoval	11.5	*McKinley	4.4	Torrance	0.0
Los Alamos	2.6	Cibola	0.0	Guadalupe	0.0
Taos	17.0	Bernalillo	6.9	Harding	0.0
*Colfax	11.9	Catron	0.0	De Baca	0.0
Santa Fe	8.2	*Socorro	0.0	Roosevelt	0.0
Hidalgo	6.7	Lincoln	0.0	*Chaves	0.0
Luna	6.0	Sierra	0.0	Otero	2.3
*San Miguel	11.1	Grant	1.8	*Eddy	0.0
		*Doña Ana	0.0	*Lea	0.0
		Union	3.7		
		*Mora	5.6		
		Quay	0.0		
		*Curry	2.4		

* Change in rating from McLemore and Hawley (1988) and Manchego et al. (1991).

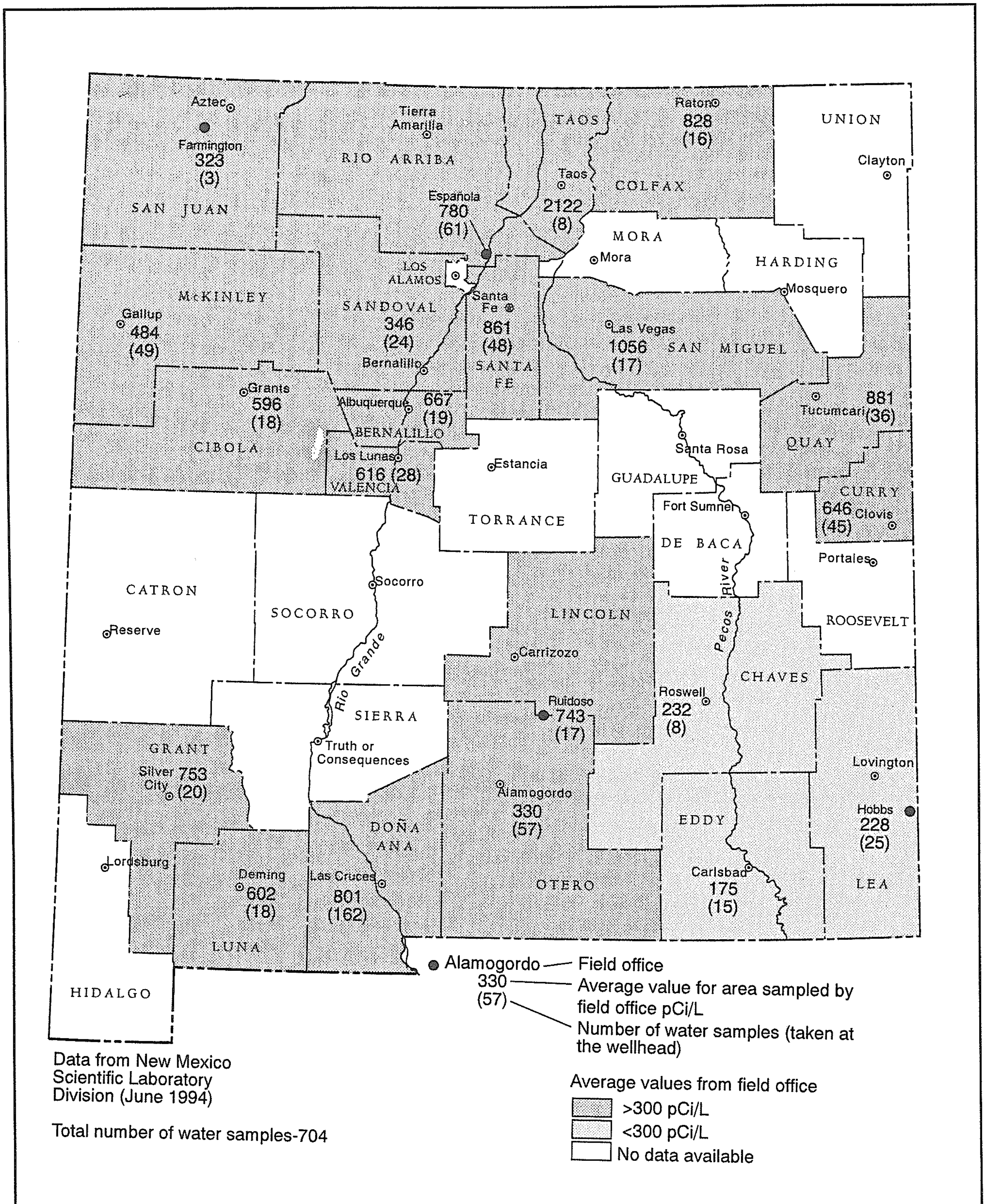

Figure 11. Radon in groundwater (at the well head) in New Mexico 1993–1994 (Berge 1994).

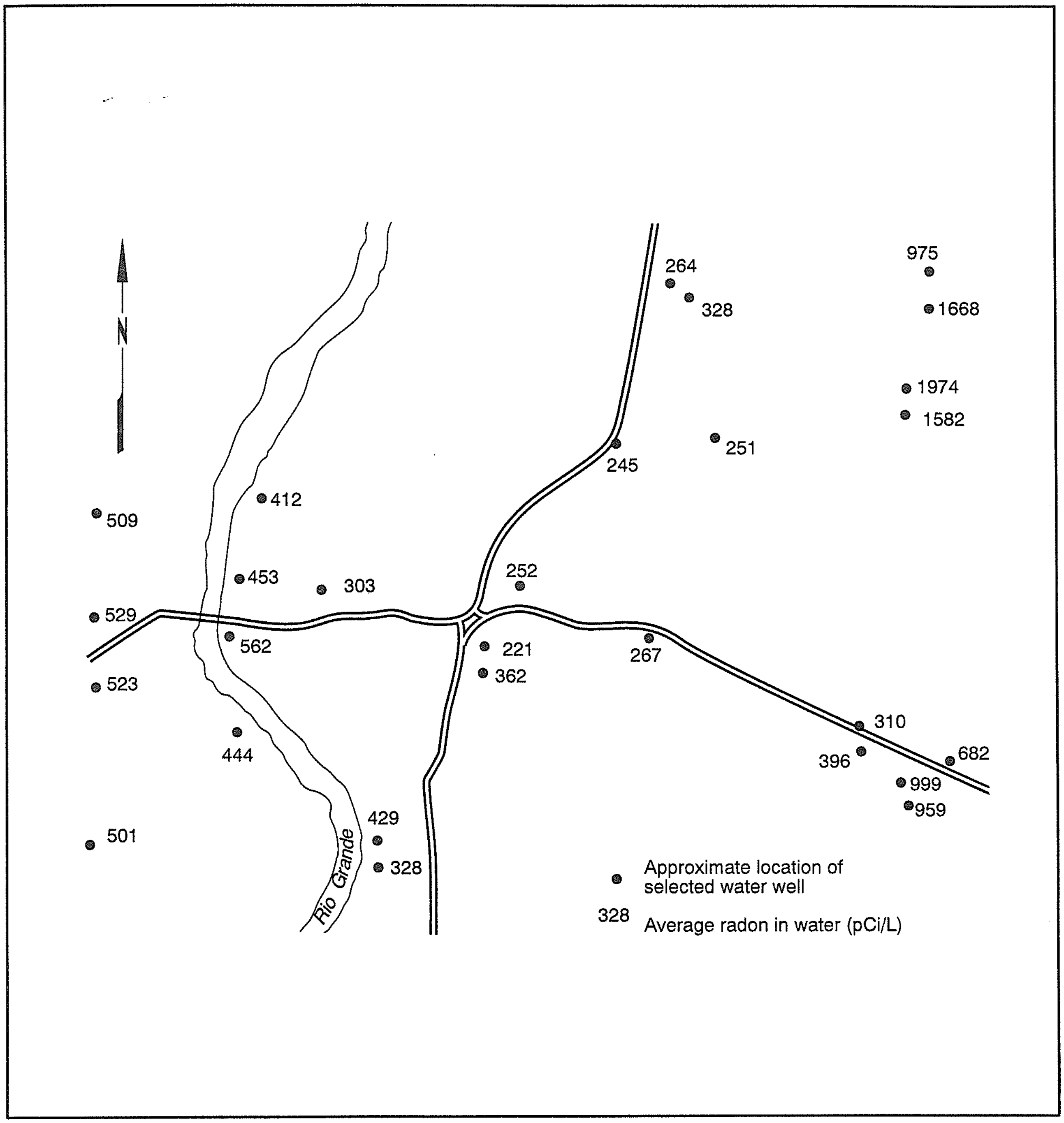

Figure 12. Radon in groundwater in Albuquerque, 1993–1994 (from City of Albuquerque, Public Works Department).

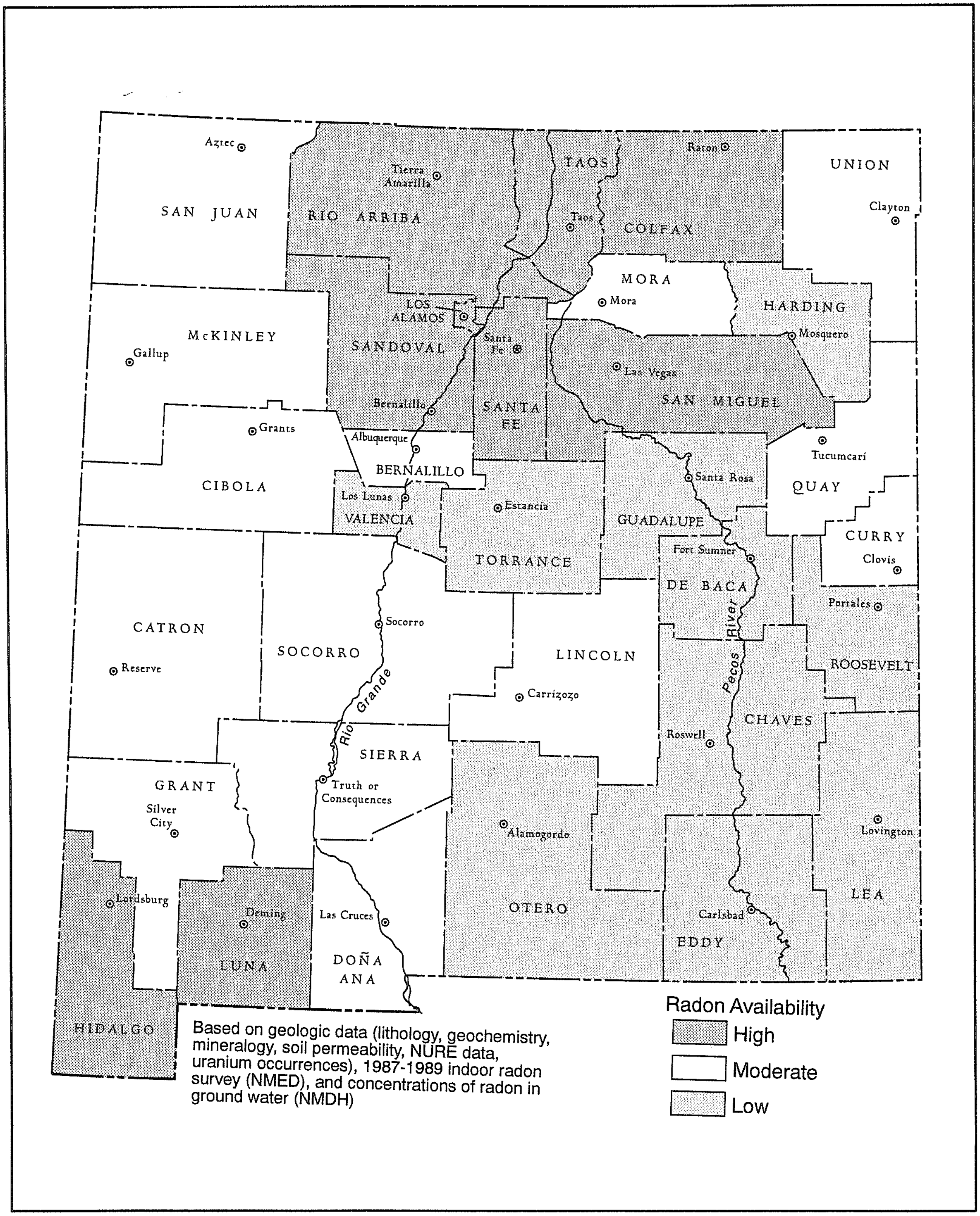

Figure 13. Radon availability in New Mexico by county (revised 1994) (Dubiel 1993).

TABLE 8. RADON AVAILABILITY RATING FOR SELECTED LARGEST CITIES IN NEW MEXICO

City	County	Classification	% homes tested >10 pCi/L (no. of homes tested)	Average radon in water (pCi/L)
Albuquerque-Rio Rancho	Bernalillo-Sandoval	moderate	73 (26)	667
Santa Fe	Santa Fe	high	10.2 (59)	861
Las Cruces	Doña Ana	*low	0.0 (67)	801
Roswell	Chaves	*low	0.0 (36)	232
Farmington	San Juan	*low	0.0 (110)	323
Hobbs	Lea	*low	0.0 (30)	228
Clovis	Curry	*low	2.6 (38)	646
Carlsbad	Eddy	*low	0.0 (32)	175
Alamogordo	Otero	low	2.7 (37)	330
Gallup	McKinley	high	4.8 (42)	484
Los Alamos-White Rock	Los Alamos	*moderate	2.6 (38)	---
Las Vegas	San Miguel	*high	12.9 (42)	1056
Grants-Milan	Cibola	moderate	0.0 (11)	596
Artesia	Eddy	low	0.0 (13)	---
Lovington	Lea	*low	0.0 (12)	---
Silver City	Grant	*moderate	2.9 (34)	753
Portales	Roosevelt	low	0.0 (34)	---
Deming	Luna	high	7.1 (42)	602
Taos	Taos	high	50.0 (4)	2122

*Change in rating from McLemore and Hawley (1988) and Manchego et al. (1991). Note: This data is provided only for informational purposes. The only way to determine the levels of indoor radon in a specific house is to test that house for radon.

TABLE 9. SUMMARY OF CRITERIA TO DETERMINE RADON AVAILABILITY IN GEOLOGIC TERRAINS IN NEW MEXICO (FIGURE 14)

Area	Geographic feature	Geologic and other criteria	Radon availability
1	Southern Rocky Mountains	Precambrian rocks, Paleozoic carbonates contain elevated uranium concentrations. Known uranium occurrences.	High
2	Grants uranium district	Cretaceous and Jurassic sedimentary rocks which host major uranium deposits.	High
3	Jemez and Tusas Mountains	Tertiary intrusive and volcanic rocks, Precambrian rocks with local elevated concentrations of uranium. Known uranium occurrences.	High
4	Sandia, Manzano, and Los Piños Mountains	Precambrian rocks enriched in uranium. Paleozoic carbonate rocks.	High
5	Southwest New Mexico	Various lithologies enriched in uranium. Deep basins with high uranium concentrations in waters. Known uranium occurrences.	High
6	Colorado Plateau	Sedimentary rocks. Known uranium occurrences.	Moderate
7	Mogollon-Datil volcanic province	Tertiary volcanic and intrusive rocks, some containing elevated uranium concentrations. Known uranium occurrences.	Moderate
8	Organ-San Andres Mountains	Precambrian and Tertiary intrusive rocks elevated in uranium. Known uranium occurrences. Paleozoic carbonates.	Moderate
9	Cornudas Mountains	Tertiary intrusives enriched in uranium and thorium.	Moderate
10	Lincoln County	Tertiary intrusives enriched in uranium and thorium.	Moderate
11	East-central New Mexico	Jurassic, Cretaceous, and Triassic sedimentary rocks. Known uranium occurrences.	Moderate
12	Laughlin Peak area	Tertiary intrusive and volcanic rocks enriched in uranium. Known uranium occurrences.	Moderate
13	Eastern New Mexico	Areas underlain by Tertiary Ogallala Formation, possibly containing elevated levels of uranium	Moderate

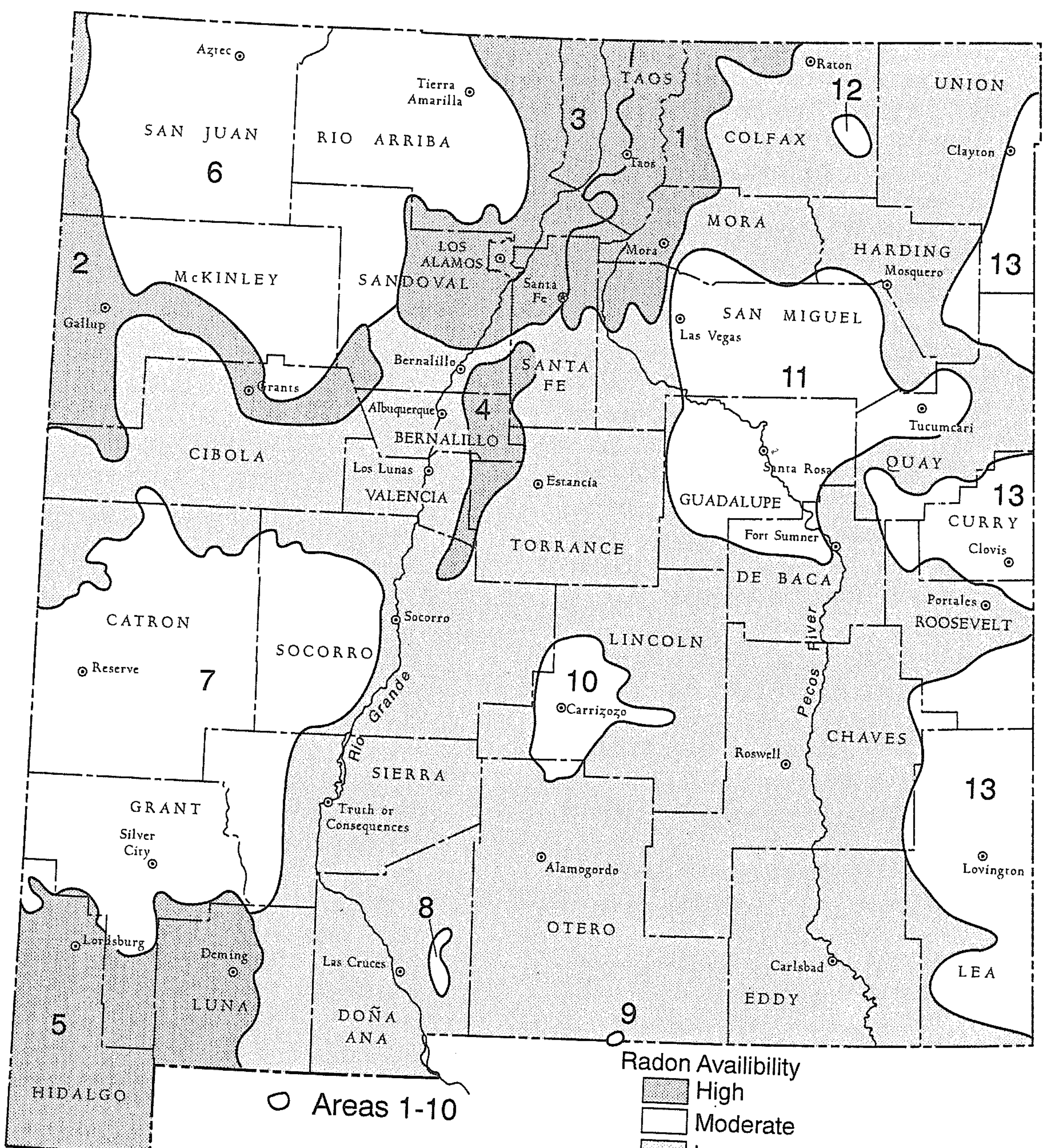

Figure 14. Preliminary radon availability map in New Mexico by geologic terrains. Areas described in Table 9.

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