UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

RADON SURVEY OF GROUND WATERS FROM BEAVER AND MILFORD BASINS, UTAH

by

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

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Introduction

A radon survey study was made of surface and ground waters of the Beaver and Milford basins of west-central Utah.

A hydrogeochemical survey conducted in the Beaver basin (Miller and others, 1980), and in the Milford basin (Miller and McHugh, 1981) suggested that the chemical environment of the Beaver and Milford basins is favorable for the occurrence of sandstone-type uranium deposits. A radon survey was made in June 1981 of these areas in order to further evaluate the possibility for sandstone-type uranium deposits.

The Beaver basin is a block-faulted depression along the eastern margin of the Basin and Range province in west-central Utah (fig. 1). The basin contains Quaternary and Tertiary lacustrine and fluviatile sediments, probably a kilometer or more thick. The basin is bounded on the east by the Tushar Mountains, which contain uranium-bearing volcanic rocks (Cunningham and Steven, 1979), and on the west by the Mineral Mountains, which contain uranium-bearing springs (Miller and others, 1979); both areas could have served as sources for any uranium deposited within the fill (Cunningham and Steven, 1979).

The Milford basin is a fault-block depression to the west of the Beaver basin (fig. 2). The basin is bounded by basalt and rhyolite flows on the north, the Black Mountains on the south, and Mineral Mountains on the east, and the Star Range, Rocky Range, and southern Wah Wah Mountains on the west. No topographic feature marks the southwest boundary of the basin where it merges with the Escalante Desert. The Beaver River enters the basin from the Beaver basin through a gap between the Mineral and Black Mountains, and flows northward through a gap into the Black Rock Desert. The Beaver River channel within the Milford basin is usually dry because the water is diverted for irrigation.

The structural basin is filled largely by Quaternary and Tertiary fluviatile and lacustrine deposits of clay, silt, sand, and gravels, mostly derived from the surrounding mountains. The basin, during Pleistocene time, was occupied in part by ancient Lake Bonneville.

Collection and analytical procedures

Water samples were collected wherever possible from both basins. Many of the windmills in the southern part of the Milford basin were not pumping, and because of frequent rains, some large irrigation wells were also not pumping. Ground-water samples were collected at the well head, except site B23, the Beaver city water supply, which was collected from a water tap.

Uranium and specific conductance were analyzed in the U.S. Geological Survey laboratory in Denver, Colorado. Uranium was analyzed by laser-excited fluorescence (Scintrex Corp., 1978), and specific conductance by conductivity bridge (Brown and others, 1970). Radon was analyzed in the field using a portable alpha scintillometer (E.D.A. Electronics, Ltd., 1977).

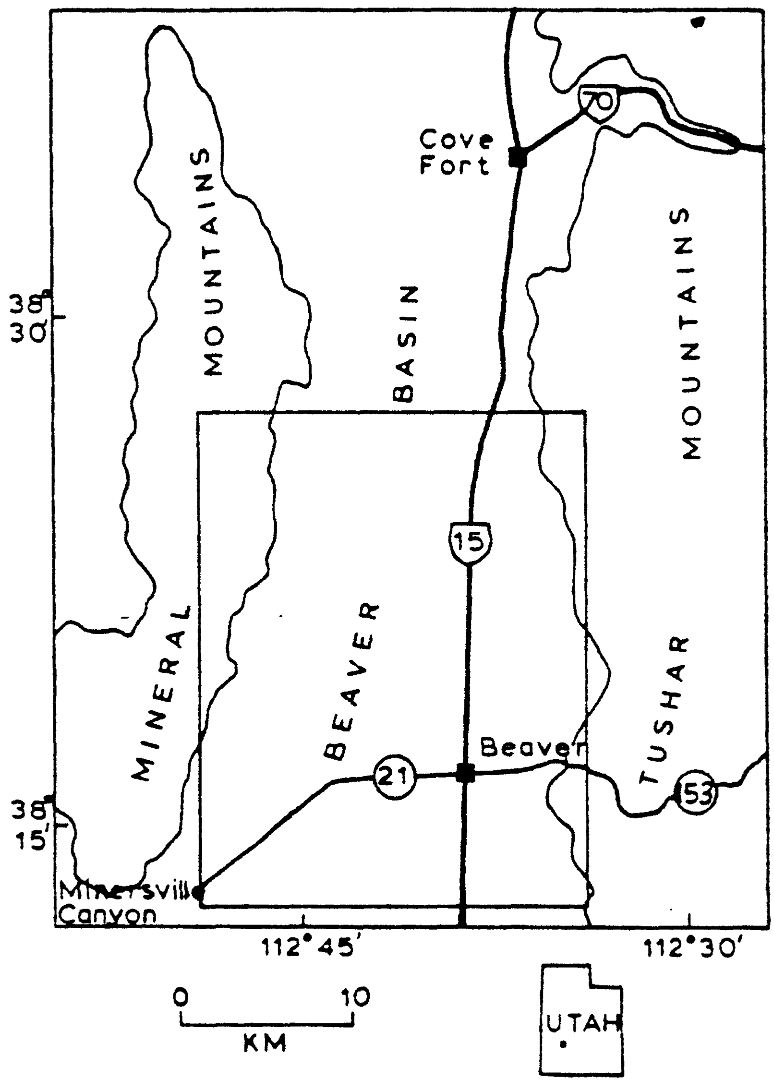

Figure 1.--Location map of Beaver basin, Utah; study area is outlined.

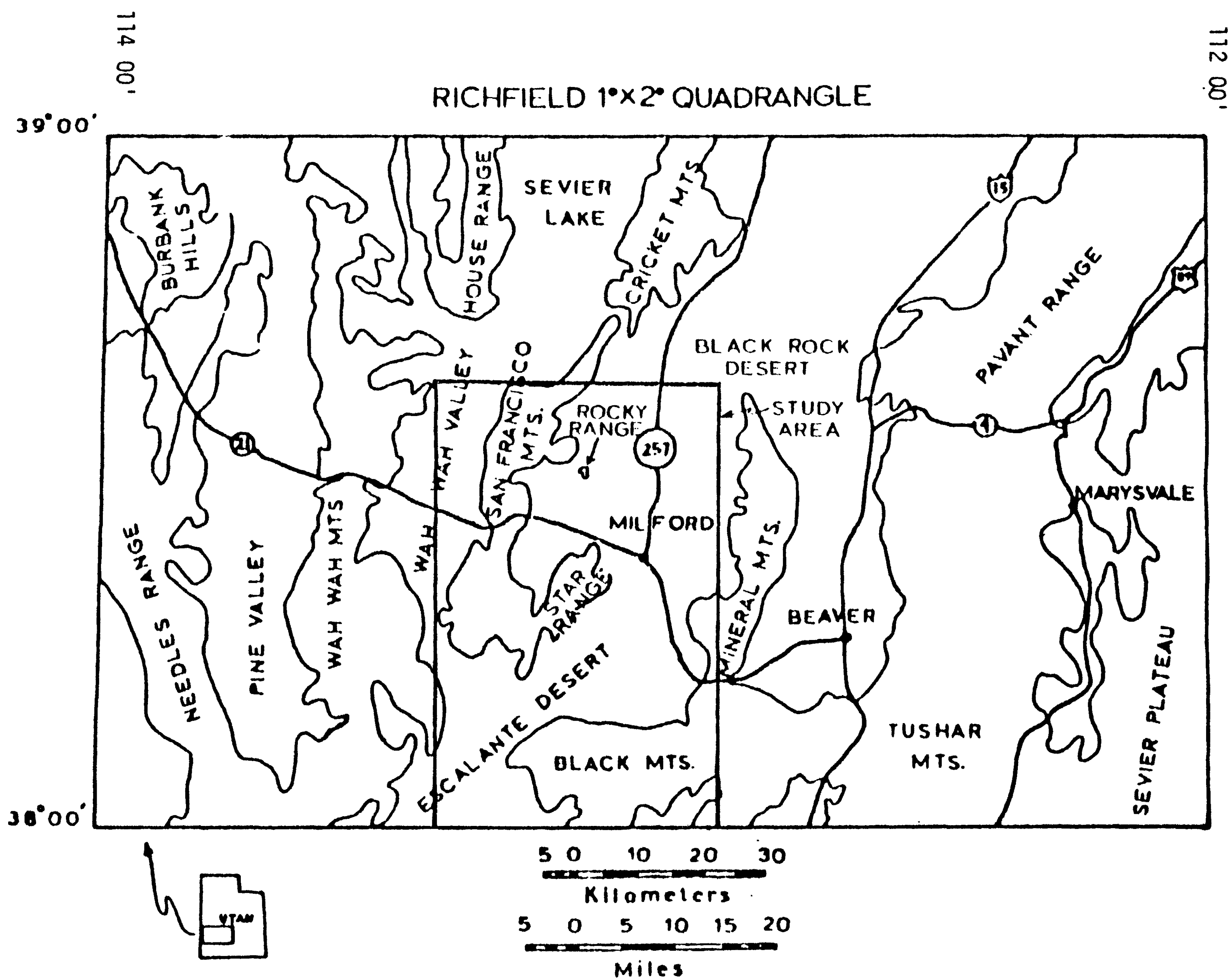

Figure 2.--Location map of the study area, Milford basin, Utah

Results

Distribution of radon in water from the Beaver and Milford basins are shown in figures 3 and 4. Table 1 is a list of sample locality numbers with analytical results for radon, uranium, and specific conductance and sample sources for all 29 water samples from the Beaver basin. Table 2 lists the same information for the 34 water samples from the Milford basin.

Statistical summary of the chemical analyses for the 29 water samples from the Beaver basin are shown in table 3; each constituent with its range, mean, geometric mean, standard deviation, and geometric deviation are listed. Correlation coefficients of the logarithm (base 10) of each constituent are also shown in table 3.

Table 4 shows the same statistical summary for the 34 water samples from the Milford basin.

Discussion and conclusion

Radon is an inert gas that is formed by the radioactive decay of ^{238}uranium (see fig. 5). Radon has a short half life of 3.8 days, and therefore is detected relatively close to its source or parent element. Because radon is an inert gas, its concentration should not be affected by normal chemical controls on water chemistry. It is affected, however, by physical controls, such as the portioning of radon between water and air. The radon contents of water will diminish rapidly with turbulent flow (Korner and Rose, 1977). Because of the lack of turbulent flow, the radon content of ground water is used as a pathfinder for uranium deposits.

The correlation of 0.79 of radon to uranium in the Beaver basin is highly significant at the 1-percent level (Snedecor and Cochran, 1967). In the Milford basin, the correlation for radon to uranium is 0.49; this also is significant at the 1-percent level. The correlation in the Milford basin is not as high, probably due to the greater distance from the primary uranium source than the Beaver basin.

The correlation of radon and uranium to specific conductance in the Beaver basin is significant at the 1-percent level. Anionic uranyl carbonate complexes are stable in an oxidizing environment, consequentially as the specific conductance increases, so does the uranium content. The correlation in the Milford basin is not significant for the 1- or 5-percent level, again probably due to the greater distance from the primary uranium source.

In the Beaver basin, the mean radon value is 1380 pico curie/L and 33.4 µg/L mean for uranium; Milford basin has mean radon value of 441 pico curie/L and 9.58 µg/L mean for uranium. The higher values in the Beaver basin are probably a reflection of closer primary sources for uranium than the Milford basin.

In the Beaver basin, sample site 47, which is located along the eastern flank of the Mineral Mountains, has the highest radon value of 8300 pCi/L; this may be due to the presence of vein-type uranium minerals in the Mineral Mountians (Miller and others, 1979). Sites 5, 6, and 8 are wells near the town of Manderfield, with values of 2050, 2600, and 5800 pCi/L radon, respectively. This area is considered favorable for sandstone-type uranium deposits (Miller and McHugh, 1981), and the anomalous radon value of 5800 pCi/L supports this conclusion. Other high radon values are shown in figure 3.

In the Milford basin, samples sites 17 and 25 have the highest radon value of 990 and 850 pCi/L, respectively. This basin has lower concentrations of uranium and radon than the Beaver basin. Much of the uranium in the Milford basin may have been carried in by water from the Beaver basin and its sources, the Tushar and Mineral Mountains. This would account for the lower concentrations of uranium and radon in the Milford basin because of the longer distance of the sample sites from the possible sources for uranium and radon.

In the Milford basin, the water table has dropped significantly, due to pumping of irrigation water (Mower and Cordova, 1974), particularly in the basin south of Milford. Uranium content in the ground water in this part of the basin is high probably due to irrigation and evaporation. Sites 17 and 25, which contained the highest concentrations of radon, with 990 and 850 pCi/L, respectively, occur in this area. Other high radon values are shown in figure 4.

The use of radon in ground water in the Beaver and Milford basins is supportive of the conclusion that sandstone-type uranium deposits may exist in the Beaver basin and possibly the Milford basin. The ground waters in the Beaver basin contain higher concentrations of uranium and radon, compared to the Milford basin, and must be considered more favorable to the formation of uranium deposits. The area near Manderfield is particularly anomalous in radon and uranium, and the ground water of one well is supersaturated with respect to uraninite (Miller and McHugh, 1981).

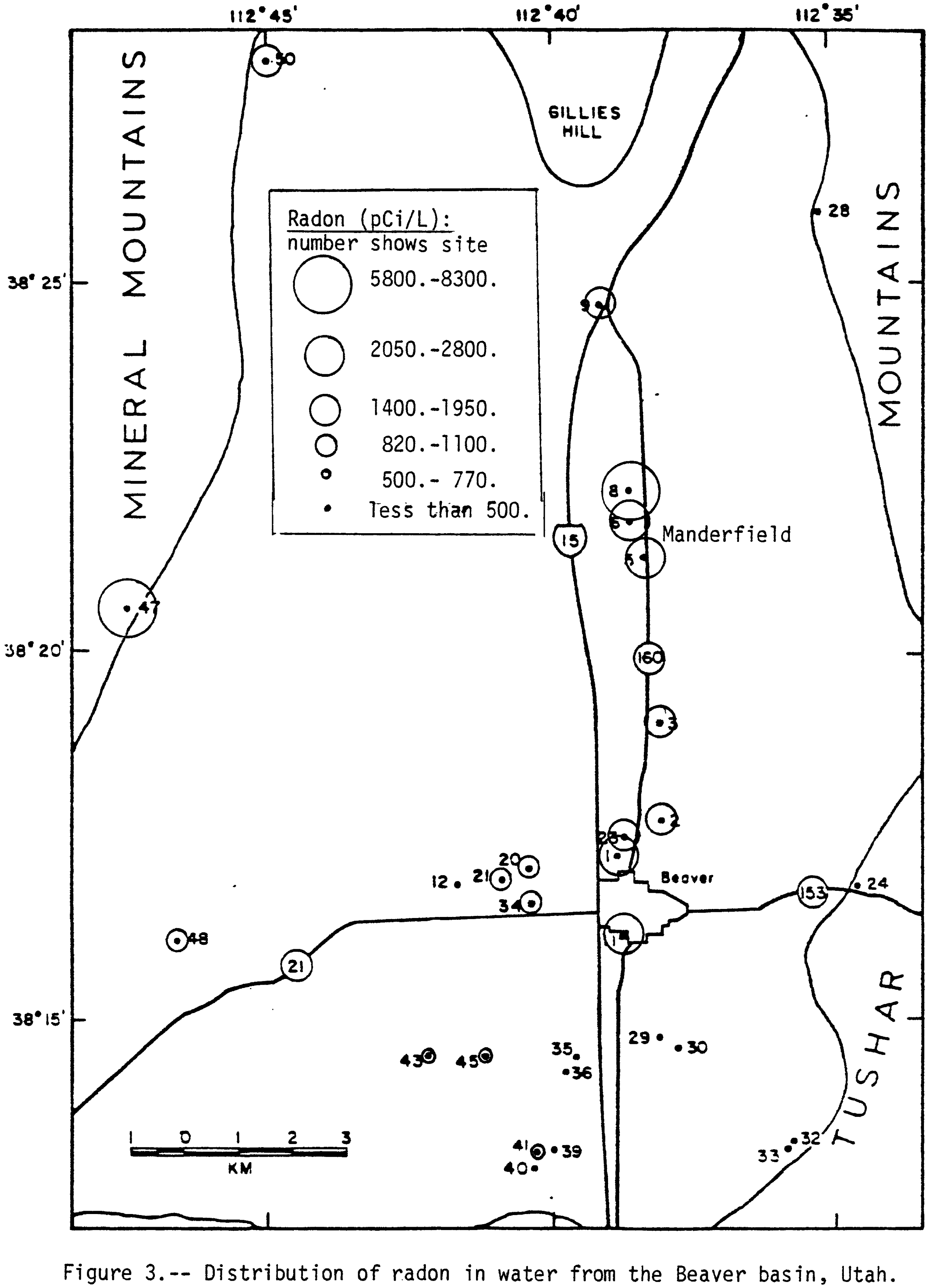

Figure 3.-- Distribution of radon in water from the Beaver basin, Utah.

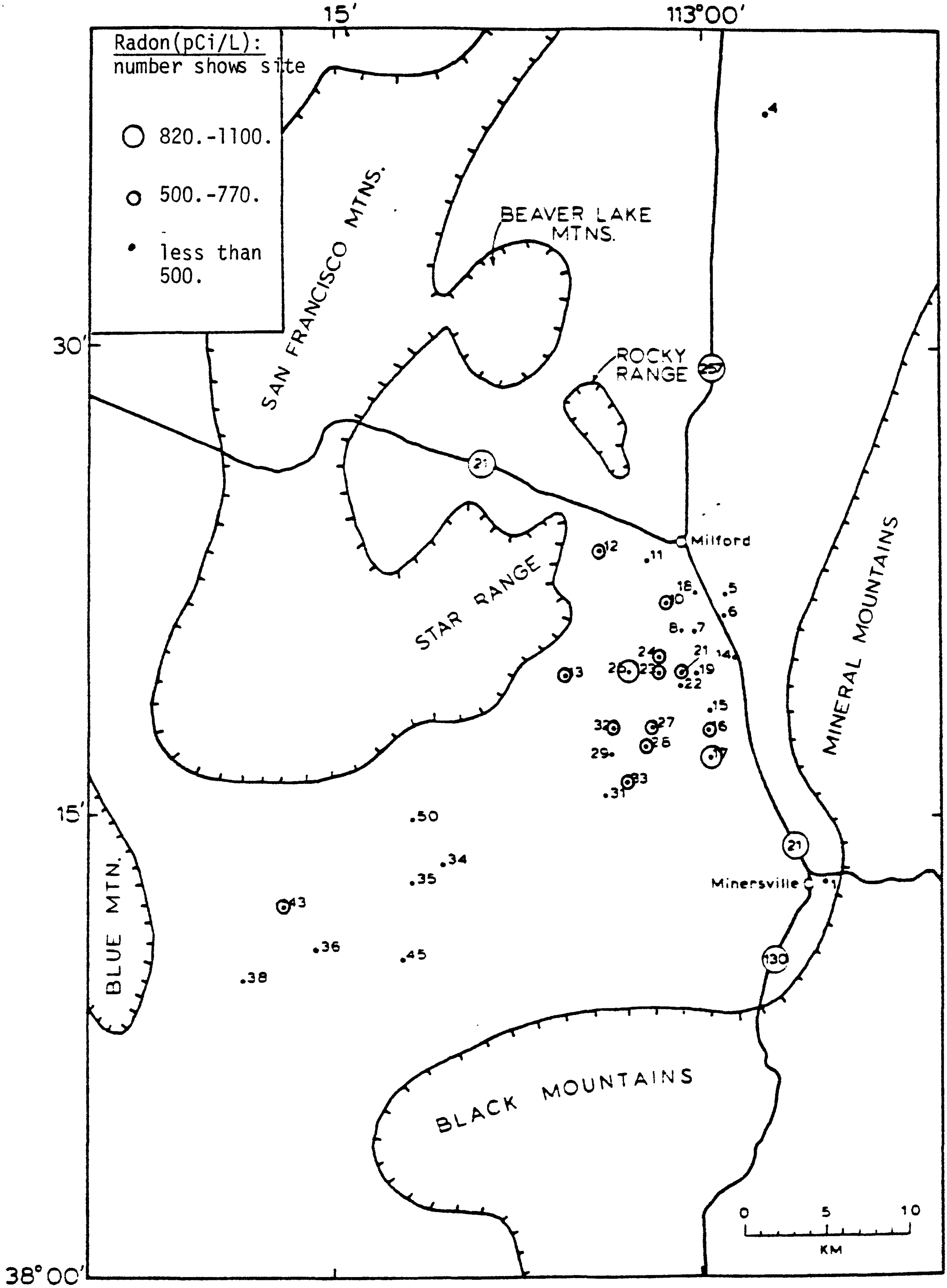

Figure 4.-- Distribution of radon in water from the Milford basin, Utah.

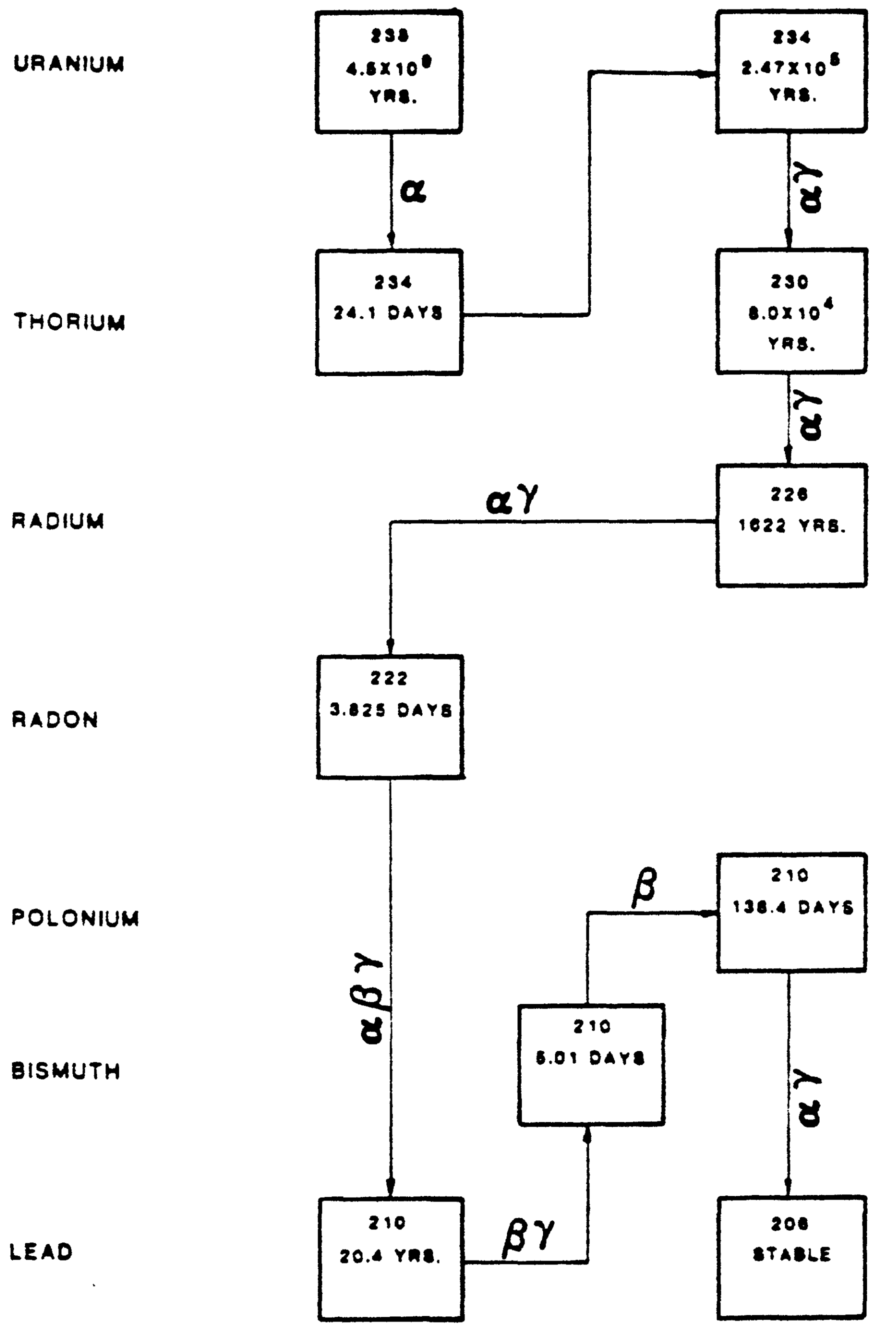

Figure 5. The U-238 decay series, neglecting all daughters with half lives less than that of Rn-222.

Table 1.--Radon, uranium, specific conductance, and source of 29 water samples, Beaver basin, Utah

Sample number	Radon pCi/L	Uranium µg/L	Specific Conductance µmhos/cm	Source of sample
B 1	2100	14	440	Irrigation well
B 2	1600	6.0	265	do
B 3	1950	5.2	395	do
B 5	2050	52	570	do
B 6	2600	12	450	do
B 8	5800	10	460	Irrigation well
B 9	1400	13	560	do
B 11	2800	3.4	295	Spring
B 12	430	<2	530	Irrigation well
B 20	1050	30	440	do
B 21	1100	11	320	Irrigation well
B 23	1800	17	360	Beaver city water
B 24	180	<.2	143	Beaver Creek
B 28	90	1.2	92	Indian Creek
B 29	260	1.2	275	Irrigation well
B 30	230	2.1	410	Kane Spring
B 32	10	<.2	122	Birch Creek
B 33	50	.2	138	South Creek
B 34	950	6.0	320	Irrigation well
B 35	70	.9	240	do
B 36	470	6.2	650	Irrigation well
B 39	150	3.4	280	do
B 40	160	2.4	270	do
B 41	520	3.1	280	do
B 43	520	.9	250	do
B 45	720	3.7	470	Spring
B 47	8300	740	490	Mud Spring
B 48	820	5.2	420	Irrigation well
B 50	1850	17	540	Mathew Spring

Table 2.--Radon, uranium, specific conductance, and source of 34 samples, Milford basin, Utah

Sample number	Radon pCi/L	Uranium µg/L	Specific Conductance µmhos/cm	Source of sample
M 1	230	0.52	1,440	Warm Spring
M 4	290	3.2	950	Windmill
M 5	180	3.9	1,040	Irrigation well
M 6	280	9.0	510	do
M 7	400	22	1,380	do
M 8	440	21	1,360	Irrigation well
M 10	550	4.3	300	do
M 11	240	1.8	1,710	do
M 12	520	6.0	1,270	Windmill
M 13	620	9.5	2.050	do
M 14	460	6.0	840	Irrigation well
M 15	360	3.9	490	do
M 16	650	30	1,130	do
M 17	990	28	820	do
M 18	250	7.1	830	do
M 19	430	9.5	1,000	Irrigation well
M 21	500	14	600	do
M 22	200	52	1,230	do
M 23	750	16	1,180	do
M 24	580	9.0	1,040	do
M 25	850	7.3	1,120	Irrigation well
M 27	510	3.2	350	do
M 28	600	4.9	550	do
M 29	310	3.7	400	do
M 31	430	20	960	do
M 32	510	5.6	750	Irrigation well
M 33	770	4.7	510	do
M 34	260	3.9	770	Windmill
M 35	370	3.9	1,070	do
M 36	160	4.3	1,450	do
M 38	420	2.4	1,650	Windmill
M 43	700	2.4	840	do
M 45	80	2.6	2,250	Thermo Hot Spring
M 50	100	<.2	500	Windmill

Table 3.--Analytical statistical summary of radon, uranium, and specific conductance for 29 water samples from Beaver basin, Utah

Constituent	Minimum	Maximum	Mean	Geometric mean	Standard deviation	Geometric deviation
Rn (pico Curie/L)	10.	8300.	1380.	611.	1803.	4.55
U (µg/L)	0.10	740.	33.4	3.82	136.	7.04
Sp. cond. (µmhos/cm)	92.	650.	361.	327.	145.	1.63

Correlation coefficients of the log-transformed data
(29 valid pairs)

	Rn	U	Specific conductance
Rn	1.00	0.79	0.72
U		1.00	0.64
Sp. cond.			1.00

Table 4.--Analytical statistical summary of radon, uranium, and specific conductance for 34 water samples from Milford basin, Utah

Constituent	Minimum	Maximum	Mean	Geometric mean	Standard deviation	Geometric deviation
Rn (pico Curie/L)	80	990.	441.	382.	219.	1.80
U (μg/L)	0.10	52.	9.58	5.65	10.7	3.23
Sp. cond. (μmhos/cm)	300.	2250.	1010.	903.	471.	1.65

Correlation coefficients of the log-transformed data
(34 valid pairs)

	Rn	U	Specific conductance
Rn	1.00	0.49	-0.19
U		1.00	0.16
Sp. cond. (μmhos/cm)			1.00

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