U.S. DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Helium soil-gas concentrations in the Torrington, Newcastle Gillette (Wyoming), and Ekalaka (Montana) 1^{o} x 2^{o} quadrangles: Data from a reconnaissance survey

by

G. M. Reimer, D. G. Murrey, and J. M. Been

Open-File Report 80-452

1980

Helium soil-gas concentrations in the Torrington, Newcastle, Gillette (Wyoming), and Ekalaka (Montana) $1^{o} \times 2^{o}$ quadrangles: Data from a reconnaissance survey

This report contains the data from a helium soil-gas survey of the Torrington, Newcastle, Gillette (Wyoming), and the Ekalaka (Montana) $1^{o} \times 2^{o}$ quadrangles. The reconnaissance survey, averaging 1 sample every 65 km^2, was conducted in June and July, 1979. A total of 838 samples were collected, all within 50 meters of roads or trails, using soil probes that had been pounded into the ground to a 1-meter depth (Reimer and Bowles, 1979). The samples were analyzed using the U.S. Geological Survey's mobile helium analyzer (Reimer, 1976; Reimer and Denton, 1978).

The presentation of the data in this report must be regarded as preliminary. Tables 1 to 4 list the sample numbers and helium concentrations for the individual quadrangles. The helium concentrations are reported in parts per billion (ppb) with respect to the concentration of helium in air at 5,240 ppb. A concentration value of 0 means the sample contained 5,240 ppb helium; a negative value means the sample contained less helium than air and may indicate the presence of significant quantities of other gases such as CO_2 and CH_4. Plates 1 to 4 show the sample locations and contours for the higher helium concentrations for each individual quadrangle. The contours are derived from a computer-generated contour plot that averages adjacent helium concentrations (Reimer and Dean, 1979). The contour interval is 20 ppb and only contours for the upper 25 percent of the helium values are drawn. The contours are continuous across common quadrangle boundaries. However, that continuum may not be valid because samples were collected in only one quadrangle at a time and six weeks were required for all samples to be

collected. Seasonal variations as well as daily variations of the soil-gas helium concentrations, which could affect overall trends and distribution, were ignored for this preliminary treatment of the data.

The mean for all 838 samples is within the interval 0-20 ppb helium; that interval contains 366 (or 44 percent) of the samples.

Previous studies have found helium associations with uranium deposits, oil and gas fields, and hot-water geothermal systems (for a review, see Dyck, 1976). The "target" size varies enormously for these various occurrences, uranium being perhaps the smallest. The larger "targets" would have a better chance of being revealed by a reconnaisance study. The following general observations pertain to this study.

In the Torrington 1^{o} x 2^{o} quadrangle, there is a pronounced contrast in the average soil-gas helium concentrations from the eastern section to the western section. The higher helium values are associated with the western flank of the Laramie Mountains and eastern Shirley Basin. The highest helium in the quadrangle is associated with the oil and gas fields near Glenrock.

In the Newcastle 1^{o} x 2^{o} quadrangle, there is a diffuse higher concentration of soil-gas helium in the western portion of the quadrangle along the flank of the Pumpkin Buttes region. The highest concentrations are found near the Hilight oil and gas region.

In the Gillette 1^{o} x 2^{o} quadrangle, the highest helium concentrations are found near the Kitty oil field and near Moorcroft. The eastern half of the quadrangle is dominated by concentrations less than the helium content of air. These low concentrations are relatively common, particularly in the eastern sections, where other gases are present such as those associated with abundant organic material including peat or lignite and coal.

In the Ekalaka 1^{o} x 2^{o} quadrangle, the highest average helium

concentrations are found in the western half of the quadrangle with just a few areas of higher values in the eastern sections. The higher average helium concentrations may be a reflection of the higher uranium concentration of the ground water and the absence of significant concentrations of other gases such as CO_2.

From this preliminary evaluation of the data, it seems that a reconnaissance helium survey can indicate the location of large oil and gas targets and also may reflect the general drainage areas where uranium is or has been carried by ground water.

REFERENCES

Dyck, Willy, 1976, The use of helium in mineral exploration: Journal of Geochemical Exploration, v. 5, p. 3-20.

Reimer, G. M., 1976, Design and assembly of a portable helium detector for evaluation as a uranium exploration instrument: U.S. Geological Survey Open-File Report 76-398, 17 p.

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., and Dean, V. C., 1979, Computer program for the Hewlett-Packard-9825A to contour and plot data collected from helium surveys: U.S. Geological Survey Open-File Report 79-865, 15 p.

Reimer, G. M., and Denton, E. H., 1978, Improved inlet system for the U.S. Geological Survey helium sniffer: U.S. Geological Survey Open-File Report 78-588, 4 p.

Table 1. Soil-gas helium concentrations for the Torrington 1 X 2 degree quadrangle. Helium concentrations are in parts per billion (ppb) with respect to helium in air (5240 ppb).

Sample Number	Helium (ppb)	Sample Number	Helium (ppb)	Sample Number	Helium (ppb)
1	0	41	40	81	0
2	0	42	40	82	18
3	40	43	10	83	18
4	20	44	0	84	0
5	20	45	-40	85	-18
6	0	46	44	86	37
7	40	47	0	87	-37
8	0	48	0	88	18
9	-40	49	0	89	0
10	20	50	0	90	37
11	220	51	0	91	18
12	240	52	44	92	20
13	0	53	44	93	20
14	40	54	88	94	60
15	40	55	44	95	0
16	0	56	44	96	0
17	18	57	0	97	0
18	0	58	0	98	20
19	37	59	22	99	0
20	0	60	42	100	0
21	0	61	21	101	40
22	0	62	42	102	40
23	18	63	21	103	40
24	40	64	42	104	0
25	0	65	42	105	36
26	20	66	0	106	0
27	-20	67	21	107	0
28	40	68	42	108	144
29	40	69	54	109	36
30	0	70	0	110	72
31	0	71	0	111	52
32	40	72	37	112	31
33	60	73	18	113	42
34	0	74	54	114	42
35	40	75	18	115	0
36	20	76	37	116	33
37	0	77	37	117	0
38	40	78	0	118	49
39	20	79	18	119	66
40	20	80	37	120	-33

Table 1. (Continued)

Sample Number	Helium (ppb)	Sample Number	Helium (ppb)	Sample Number	Helium (ppb)
121	66	161	-34	201	-35
122	33	162	-34	202	-35
123	33	163	-200	203	-17
124	33	164	0	204	-17
125	33	165	-34	205	0
126	33	166	0	206	-17
127	66	167	20	207	-35
128	66	168	0	208	0
129	33	169	20		
130	33	170	-80		
131	33	171	39		
132	0	172	0		
133	33	173	0		
134	33	174	0		
135	-33	175	39		
136	0	176	0		
137	0	177	0		
138	-33	178	0		
139	33	179	-70		
140	-83	180	70		
141	0	181	0		
142	-17	182	-36		
143	0	183	-36		
144	17	184	-54		
145	0	185	-36		
146	0	186	-36		
147	0	187	-36		
148	35	188	-36		
149	35	189	-36		
150	17	190	-54		
151	0	191	-18		
152	-35	192	0		
153	0	193	34		
154	0	194	0		
155	0	195	0		
156	-17	196	0		
157	17	197	0		
158	-17	198	0		
159	0	199	0		
160	0	200	0		

Table 2. Soil-gas helium concentrations for the Newcastle 1 X 2 degree quadrangle. Helium concentrations are in parts per billion (ppb) with respect to helium in air (5240 ppb).

Sample Number	Helium (ppb)	Sample Number	Helium (ppb)	Sample Number	Helium (ppb)
1	36	41	20	81	36
2	18	42	60	82	-36
3	-18	43	15	83	36
4	-36	44	0	84	72
5	18	45	15	85	0
6	18	46	-75	86	0
7	18	47	19	87	0
8	36	48	-19	88	0
9	18	49	-57	89	19
10	36	50	0	90	0
11	0	51	0	91	36
12	0	52	0	92	0
13	18	53	-19	93	72
14	-36	54	0	94	0
15	0	55	0	95	0
16	18	56	-36	96	36
17	18	57	0	97	0
18	0	58	-69	98	0
19	36	59	-69	99	18
20	-18	60	-86	100	36
21	0	61	-155	101	36
22	72	62	17	102	18
23	36	63	-34	103	18
24	18	64	-17	104	-18
25	-36	65	17	105	0
26	50	66	0	106	-18
27	0	67	34	107	0
28	35	68	-17	108	0
29	17	69	0	109	35
30	0	70	17	110	0
31	0	71	0	111	0
32	35	72	0	112	0
33	0	73	-17	113	35
34	0	74	0	114	0
35	-17	75	0	115	0
36	-35	76	0	116	-17
37	0	77	18	117	-17
38	30	78	18	118	-17
39	15	79	-18	119	-17
40	0	80	-18	120	-17

Table 2. (Continued)

Sample Number	Helium (ppb)	Sample Number	Helium (ppb)
121	0	161	42
122	-51	162	0
123	-35	163	0
124	35	164	-42
125	17	165	-63
126	17	166	21
127	-35	167	42
128	0	168	74
129	-35	169	0
130	-35	170	-42
131	0	171	-37
132	0	172	-21
133	0	173	0
134	17	174	0
135	0	175	0
136	0	176	0
137	-17	177	0
138	0	178	0
139	30	179	37
140	30	180	63
141	0	181	0
142	420	182	0
143	300	183	0
144	-60	184	37
145	300	185	-37
146	-120	186	-54
147	90	187	-21
148	-60	188	-54
149	-60	189	37
150	-60	190	0
151	0	191	0
152	-60	192	0
153	-60	193	0
154	30	194	0
155	60	195	21
156	0	196	0
157	0	197	-54
158	-21	198	-54
159	-21		
160	0		

Table 3. Soil-gas helium concentrations for the Gillette 1 X 2 degree quadrangle. Helium concentrations are in parts per billion (ppb) with respect to helium in air (5240 ppb).

Sample Number	Helium (ppb)	Sample Number	Helium (ppb)	Sample Number	Helium (ppb)
1	-144	41	0	81	-38
2	-90	42	-18	82	-57
3	72	43	-18	83	-19
4	36	44	0	84	-38
5	0	45	0	85	-38
6	34	46	0	86	0
7	34	47	0	87	-17
8	0	48	0	88	50
9	0	49	-18	89	17
10	0	50	-48	90	0
11	0	51	-32	91	0
12	17	52	-48	92	0
13	34	53	-35	93	17
14	17	54	-35	94	0
15	0	55	35	95	0
16	-17	56	53	96	0
17	-34	57	-35	97	-17
18	-34	58	-35	98	0
19	-17	59	-71	99	-64
20	0	60	-71	100	-32
21	-72	61	18	101	-64
22	-72	62	-18	102	-48
23	-36	63	-19	103	-80
24	18	64	-75	104	-32
25	0	65	-38	105	-64
26	-32	66	0	106	0
27	0	67	0	107	-66
28	-16	68	-19	108	-83
29	0	69	19	109	-132
30	-16	70	0	110	-66
31	-16	71	0	111	-33
32	-32	72	-19	112	-66
33	0	73	-38	113	-17
34	-70	74	-57	114	0
35	0	75	-57	115	0
36	-32	76	-38	116	-17
37	0	77	-38	117	17
38	-32	78	-38	118	-19
39	-18	79	-38	119	0
40	-16	80	-38	120	-38

Table 3. (Continued)

Sample Number	Helium (ppb)	Sample Number	Helium (ppb)
121	0	161	-18
122	-75	162	-94
123	-38	163	-38
124	0	164	-132
125	-19	165	-17
126	19	166	-50
127	-19	167	0
128	0	168	-33
129	18	169	-50
130	-36	170	-17
131	-36	171	0
132	36	172	-33
133	0	173	-66
134	18	174	0
135	0	175	-48
136	54	176	0
137	0	177	-48
138	0	178	-64
139	0	179	-83
140	0	180	-50
141	18	181	-33
142	36	182	-66
143	-18	183	-33
144	-36	184	-50
145	36	185	-33
146	0	186	-50
147	36	187	-99
148	-54	188	0
149	0	189	0
150	0	190	0
151	0	191	-34
152	0	192	17
153	34	193	34
154	-34	194	-17
155	0	195	0
156	34	196	0
157	35	197	0
158	-35	198	-17
159	35	199	-17
160	-71		

Table 4. Soil-gas helium concentrations for the Ekalaka 1 X 2 degree quadrangle. Helium concentrations are in parts per billion (ppb) with respect to helium in air (5240 ppb).

Sample Number	Helium (ppb)	Sample Number	Helium (ppb)	Sample Number	Helium (ppb)
1	35	41	16	81	0
2	-17	42	16	82	30
3	0	43	0	83	15
4	0	44	0	84	-32
5	0	45	0	85	-48
6	0	46	16	86	-32
7	0	47	0	87	-18
8	0	48	16	88	-18
9	35	49	-16	89	-65
10	0	50	-16	90	-32
11	0	51	16	91	-20
12	0	52	-16	92	0
13	0	53	-16	93	-50
14	0	54	0	94	0
15	0	55	-64	95	0
16	0	56	-16	96	38
17	-17	57	0	97	0
18	-32	58	0	98	0
19	-32	59	32	99	0
20	0	60	18	100	38
21	-32	61	0	101	38
22	0	62	36	102	0
23	16	63	36	103	0
24	0	64	36	104	-38
25	-32	65	0	105	-19
26	0	66	0	106	0
27	-16	67	0	107	0
28	-33	68	-54	108	-19
29	-33	69	-36	109	0
30	-33	70	-18	110	0
31	0	71	-72	111	-38
32	-49	72	-18	112	-55
33	-49	73	-72	113	-75
34	-85	74	-72	114	-19
35	-17	75	36	115	0
36	-33	76	30	116	-37
37	-17	77	0	117	-56
38	16	78	60	118	-37
39	0	79	30	119	36
40	0	80	0	120	36

Table 4. (Continued)

Sample Number	Helium (ppb)	Sample Number	Helium (ppb)	Sample Number	Helium (ppb)
121	38	161	34	201	-45
122	0	162	51	202	-60
123	0	163	0	203	-60
124	0	164	0	204	-30
125	-17	165	17	205	-30
126	17	166	17	206	30
127	17	167	34	207	15
128	17	168	0	208	17
129	0	169	0	209	51
130	0	170	0	210	0
131	0	171	-30	211	0
132	0	172	60	212	-32
133	0	173	47	213	-32
134	33	174	-16	214	0
135	0	175	31	215	0
136	66	176	47	216	0
137	-33	177	31	217	0
138	-66	178	0	218	0
139	33	179	16	219	32
140	-33	180	31	220	68
141	-33	181	31	221	34
142	-33	182	47	222	34
143	-33	183	0	223	17
144	-33	184	16	224	51
145	0	185	47	225	-34
146	0	186	16	226	-17
147	34	187	31	227	17
148	68	188	31	228	-34
149	34	189	19	229	34
150	68	190	0	230	17
151	68	191	-19	231	51
152	34	192	0	232	17
153	51	193	0	233	0
154	34	194	-19		
155	34	195	0		
156	17	196	0		
157	51	197	0		
158	17	198	-19		
159	68	199	57		
160	34	200	-60		

EXPLANATION OF PLATES

Plate 1 --Helium soil-gas contour map of the Torrington, Wyoming 1 X 2 quadrangle including the eastern section of the Shirley Basin in the Casper, Wyoming 1 X 2 quadrangle. Sample locations are shown by dots and helium values for the corresponding sample numbers are given in Table 1. The contour interval is 20 parts per billion (ppb) helium with respect to air at 5240 ppb. The contours, with a base value of 20 ppb, represent only the upper 25 percent of all samples (838) collected for the entire survey. The contours span the range from 20 to 80 ppb; all values greater than 80 ppb are grouped and values less than 20 ppb are not contoured.

(Explanation of plates continued)

Plate 2 -- Helium soil-gas contour map of the Newcastle, Wyoming 1 X 2 quadrangle. Sample locations are shown by dots and the helium values for the corresponding sample numbers are given in Table 2. The contour interval is 20 parts per billion (ppb) helium with respect to air at 5240 ppb. The contours, with a base value of 20 ppb, represent only the upper 25 percent of all samples (838) collected for the entire Powder River Basin reconnaissance survey. The contours span the range from 20 to 80 ppb; all values greater than 80 ppb are grouped and values less than 20 ppb are not contoured.

Plate 3 -- Helium soil-gas contour map of the Gillette, Wyoming 1 X 2 quadrangle. Sample locations are shown by dots and the helium values for the corresponding sample numbers are given in Table 3. The contour interval is 20 parts per billion (ppb) helium with respect to air at 5240 ppb. The contours, with a base value of 20 ppb, represent only the upper 25 percent of all samples (838) collected for the entire Powder River Basin reconnaissance survey. The contours span the range from 20 to 80 ppb; all values greater than 80 ppb are grouped and values less than 20 ppb are not contoured.

(Explanation of plates continued)

Plate 4 -- Helium soil-gas contour map of the Ekalaka, Montana 1 X 2 quadrangle. Sample locations are shown by dots and the helium values for the corresponding sample numbers are given in Table 4. The contour interval is 20 parts per billion (ppb) helium with respect to air at 5240 ppb. The contours, with a base value of 20 ppb, represent only the upper 25 percent of all samples (838) collected for the entire Powder River Basin reconnaissance survey. The contours span the range from 20 to 80 ppb; all values greater than 80 ppb are grouped and values less than 20 ppb are not contoured.