Radioelement Concentrations in Archean Granites of Central Wyoming

by

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INTRODUCTION

The region of central Wyoming (fig. 1) is a major uranium province with several producing uranium districts (Butler 1972). All of the current production is from Cenozoic sandstones for which the dominant provenance is nearby Archean granitic terrane (Seeland 1976, 1978). Several isotopic studies have lead to the conclusion that the Granite Mountains lost more than enough uranium to account for that in the surrounding uranium districts and that the timing of that loss was compatible with the age of ore deposition (Rosholt and Bartel, 1969, Rosholt and others, 1973; Stuckless and Nkomo, 1978, and Ludwig, 1978 and 1979). Seeland (1978) noted that all of the deposits within the Powder River Basin were situated in arkoses that had been derived from the northern Laramie Range or from the Granite Mountains. Small deposits in the Owl Creek Mountains and the Wind River Range (fig. 1) are within Archean granite or in sandstone derived from Archean granite that crops out only a few kilometers away.

Although volcanic detritus is a common component of the mineralized sandstones and has been proposed as a source for the uranium, we consider its significance as a uranium source to be small because it is also a component of the sediments where uranium deposits are unknown. The distribution of uranium deposits seems to be controlled by the Archean granite provenance. Thus, a characterization of the radioelement distribution within the Archean granites of central Wyoming may be useful in assessing uranium potential in other granitic areas. In this paper we report radioelement concentration data with statistical analyses for samples from the Granite Mountains, the northern Laramie Range, the Hartville uplift, the Owl Creek Mountains, and the Wind River Range.

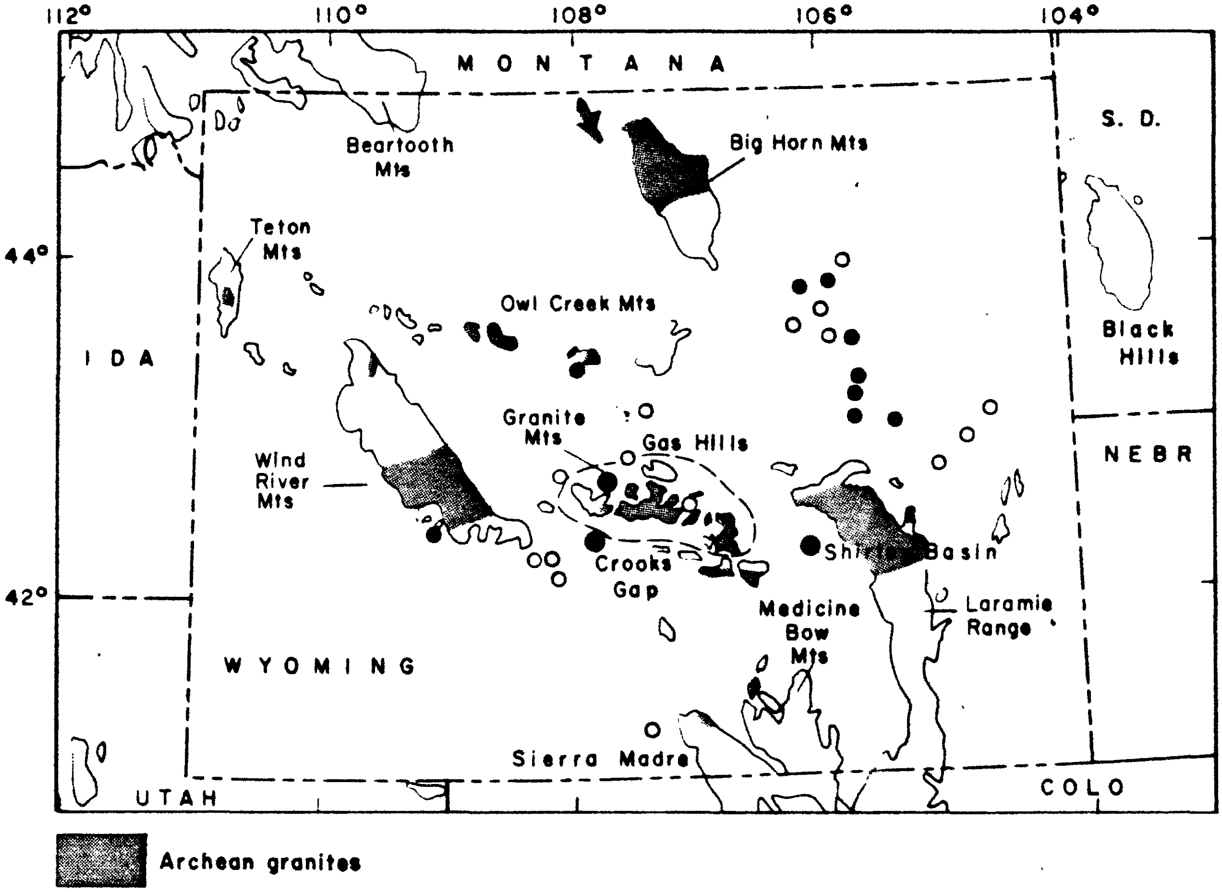


Figure 1. Generalized geologic map of Wyoming showing areas of Archean rocks and the locations of uranium deposits (circles and dots). The large dots represent uranium districts with reserves plus production of ore (U_3O_8>0.1%) of more than 1,000,000 tons. Deposits with ore reserves between 1,000 and 1,000,000 tons are shown by small dots. Deposits with reserves between 1 and 1,000 tons are shown by circles. Uranium data from Butler (1972).

ANALYTICAL PROCEDURES

Most of the data used in this study were obtained by sealed-can γ-ray spectrometry (Bunker and Bush, 1966, 1967). Uranium values determined by this technique are actually radium-equivalent uranium values (RaeU) which represent the amount of uranium needed for secular equilibrium with the measured radium. Precision for RaeU and Th is generally ± the quantity 2 percent of the reported amount plus 0.1 ppm absolute, however samples with very high (>10) or very low (<1) Th/RaeU ratios have, poorer precision for the less abundant element. Potassium contents are generally precise to within ± the quantity 2 percent of the reported amount plus .03 percent absolute but again anomalously low K/RaeU or K/Th ratios indicate poorer precisions. A few of the reported uranium and thorium values were obtained by isotope dilution and mass spectrometry (samples NH-1-73 through SB-89H60, table 1 from Nkomo and others, 1979; samples GPA-1 through GPA-13, table 1, from Stuckless and Nkomo, unpublished data). Potassium values for samples GPA-1 through GPA-13 (table 1) were obtained by X-ray fluorescence. Values for samples BBL-1 through TCM-DDH5 have been previously reported by Stuckless and others (1978), and values for samples 71TDG6 through 72TDG47 are from Nkomo and others (1978).

All of the samples were collected from outcrops or within a few meters of the surface except as noted in the depth column of table 1. At each outcrop, an attempt was made to obtain the freshest material possible. Exterior surfaces were removed. Nonetheless, all of the samples showed some signs of weathering, including samples from blasted outcrops, and as much as 25 percent of the more mafic samples from the Granite Mountains are strongly weathered.

Statistical evaluation of the analytical data was made by use of the USGS RASS-STATPAC computer system (VanTrump and Miesch, 1977).

Table 1.- Radioelement contents and ratios for Archean granitic rocks of central Wyoming

Sample	Latitude	Longitude	RaeU ppm	Th ppm	K (wt %)	Th/RaeU	Th/K*	RaeU/K*	Type†	Depth m
BBL-1	42 30 21	107 13 21	1.86	26.70	3.73	14.35	7.16	.50	2	.0
BBL-2	42 31 17	107 13 38	2.57	33.80	4.55	13.15	7.43	.56	2	.0
BBL-3	42 32 22	107 11 15	13.40	39.70	.06	2.96	661.67	223.33	7	.0
BBL-4	42 32 3	107 10 20	5.04	45.50	4.30	9.03	10.58	1.17	2	.0
BBL-5	42 31 26	107 9 49	3.30	50.40	4.44	15.27	11.35	.74	2	.0
BBL-6	42 31 9	107 10 49	1.98	27.10	3.76	13.69	7.21	.53	2	.0
BBL-7	42 30 44	107 11 24	2.01	44.50	4.40	22.14	10.11	.46	2	.0
BBL-8	42 30 56	107 12 27	3.26	55.80	4.48	17.12	12.46	.73	2	.0
BBL-9	42 30 41	107 14 36	.73	19.00	4.26	26.03	4.46	.17	6	.0
BBL-10	42 36 27	107 11 14	1.40	21.40	2.39	15.29	8.95	.59	2	.0
BBL-11	42 37 8	107 11 45	1.50	34.30	4.46	22.87	7.69	.34	2	.0
BBL-12	42 36 2	107 12 43	1.70	58.70	3.64	34.53	16.13	.47	2	.0
BBL-13	42 36 34	107 13 34	2.00	39.30	4.32	19.65	9.10	.46	4	.0
BBL-14	42 35 27	107 14 12	3.60	15.60	3.97	4.33	3.93	.91	2	.0
BBL-15	42 30 3	107 14 9	2.10	31.30	4.40	14.90	7.11	.48	2	.0
BBSW-1	42 30 50	105 52 26	3.60	36.70	4.20	10.19	8.74	.86	2	.0
BR-1	42 29 27	107 29 41	3.50	65.20	4.51	18.63	14.46	.78	2	.0
BR-2	42 28 46	107 26 42	2.70	62.00	3.33	22.96	18.62	.81	2	.0
BR-3	42 29 19	107 25 49	2.60	59.50	4.19	22.88	14.20	.62	2	.0
BR-4	42 29 54	107 22 47	1.40	40.90	2.53	29.21	16.17	.55	2	.0
BRG-1	42 30 33	107 39 16	13.50	49.80	.47	3.69	105.96	28.72	7	.0
BRG-1A	42 30 33	107 39 16	8.59	73.20	1.09	8.52	67.16	7.88	7	.0
BRG-3	42 33 4	107 43 45	3.93	32.60	3.22	8.30	10.12	1.22	2	.0
BRG-4	42 31 35	107 43 6	3.08	29.20	4.06	9.48	7.19	.76	2	.0
BRG-5	42 33 53	107 42 49	2.62	38.20	4.89	14.58	7.81	.54	2	.0
BRG-6	42 30 54	107 41 1	3.40	20.60	3.91	6.06	5.27	.87	2	.0
BRG-7	42 31 23	107 38 48	8.70	42.20	4.63	4.85	9.11	1.88	2	.0
BRG-8	42 30 28	107 37 25	6.80	37.10	4.27	5.46	8.69	1.59	2	.0
BRG-9	42 35 11	107 38 13	1.85	16.80	3.88	9.08	4.33	.48	6	.0
BRG-10	42 32 22	107 43 38	5.00	63.30	4.50	12.66	14.07	1.11	2	.0
BRG-11	42 34 17	107 42 8	2.40	19.30	4.81	8.04	4.01	.50	6	.0
BRG-12	42 33 49	107 44 0	1.70	22.00	4.72	12.94	4.66	.36	2	.0
BRG-CR-1	42 30 34	107 39 6	10.50	69.10	4.31	6.58	16.03	2.44	2	30.7
BRG-CR-2	42 30 34	107 39 6	10.50	64.50	4.62	6.14	13.96	2.27	2	47.9
BRG-CR-3	42 30 34	107 39 6	12.20	66.00	4.50	5.41	14.67	2.71	2	57.2
BRG-DDH7	42 35 10	107 41 59	2.87	44.60	3.82	15.54	11.68	.75	2	.3
BRG-M77	42 30 39	107 39 39	2.30	17.70	4.05	7.70	4.37	.57	6	23.6
BRG-M102	42 30 39	107 39 39	5.20	45.40	4.31	8.73	10.53	1.21	2	31.2
BRG-M227	42 30 39	107 39 39	9.20	47.10	4.20	5.12	11.21	2.19	2	69.3
BRG-M427	42 30 39	107 39 39	11.10	37.90	2.02	3.41	18.76	5.50	2	130.3
BRQ-1	42 21 45	107 0 43	1.00	33.00	3.93	33.00	8.40	.25	2	.0
FR-1	42 28 45	107 7 9	2.60	51.40	4.16	19.77	12.36	.62	2	.0
FR-2	42 27 48	107 7 2	1.50	43.20	3.38	28.80	12.78	.44	2	.0
FR-3	42 28 32	107 6 6	5.00	75.60	.27	15.12	280.00	18.52	7	.0
FR-4	42 28 34	107 6 5	2.40	48.90	4.48	20.38	10.92	.54	2	.0

Table 1.- Radioelement contents and ratios for Archean granitic rocks of central Wyoming--continued

Sample	Latitude	Longitude	RaeU ppm	Th ppm	K (wt %)	Th/RaeU	Th/K*	RaeU/K*	Type†	Depth m
FR-5	42 29 17	107 5 6	1.90	57.50	4.40	30.26	13.07	.43	2	.0
FR-6	42 29 45	107 4 21	2.90	49.60	4.43	17.10	11.20	.65	2	.0
FR-7	42 29 38	107 2 56	1.90	54.70	4.34	28.79	12.60	.44	2	.0
FR-8	42 28 52	107 4 30	1.70	69.20	4.49	40.71	15.41	.38	2	.0
FR-9	42 28 56	107 3 18	3.60	68.20	4.09	18.94	16.67	.88	2	.0
FR-10	42 27 35	107 5 23	.70	24.50	4.60	35.00	5.33	.15	2	.0
FR-11	42 27 20	107 4 24	4.40	112.00	2.46	25.45	45.53	1.79	4	.0
FR-12	42 28 19	107 3 59	5.20	71.00	4.52	13.65	15.71	1.15	2	.0
FR-13	42 27 57	107 4 31	1.00	23.70	5.01	23.70	4.73	.20	6	.0
FR-14	42 27 9	107 5 58	.70	28.00	3.18	40.00	8.81	.22	2	.0
FR-15	42 26 43	107 4 59	.80	17.50	2.41	21.88	7.26	.33	4	.0
FR-16	42 27 27	107 0 22	2.30	72.00	4.27	31.30	16.86	.54	2	.0
FR-17	42 26 26	107 0 46	2.00	25.60	4.40	12.80	5.82	.45	2	.0
FR-18	42 22 50	107 0 38	2.40	31.00	4.02	12.92	7.71	.60	2	.0
FR-19	42 28 22	107 0 41	5.00	69.90	4.52	13.98	15.46	1.11	2	.0
GR-3	42 31 2	107 52 40	2.23	26.20	2.07	11.75	12.66	1.08	7	.9
GR-4	42 31 2	107 52 40	7.91	17.40	.78	2.20	22.31	10.14	7	.9
GR-5	42 31 2	107 52 40	2.64	26.10	.95	9.89	27.47	2.78	7	.9
IR-1	42 26 7	107 10 44	.49	10.00	3.35	20.41	2.99	.15	6	.0
IR-2	42 26 5	107 9 52	1.01	13.50	2.45	13.37	5.51	.41	4	.0
IR-4	42 26 13	107 8 39	.45	4.90	4.55	10.89	1.08	.10	6	.0
IR-5	42 26 25	107 8 7	.83	14.80	2.48	17.83	5.97	.33	4	.0
IR-6	42 26 41	107 7 31	.75	20.70	3.05	27.60	6.79	.25	2	.0
IR-8	42 24 55	107 8 53	1.01	38.80	2.50	38.42	15.52	.40	4	.0
IR-9	42 24 14	107 9 8	1.27	8.50	3.55	6.69	2.39	.36	4	.0
IR-11	42 24 5	107 8 41	.86	43.60	2.45	50.70	17.80	.35	4	.0
IR-12	42 23 47	107 9 7	.41	5.40	4.08	13.17	1.32	.10	6	.0
IR-13	42 23 40	107 9 59	1.72	35.40	3.19	20.58	11.10	.54	2	.0
IR-14	42 23 37	107 10 49	.79	20.60	3.94	26.08	5.23	.20	6	.0
IR-15	42 26 34	107 10 18	.98	12.30	2.57	12.55	4.79	.38	4	.0
IR-16	42 26 44	107 9 28	.43	21.80	3.57	50.70	6.11	.12	6	.0
IR-17	42 26 42	107 12 16	.88	19.20	2.17	21.82	8.85	.41	2	.0
IR-18	42 28 0	107 12 16	1.41	26.70	3.40	18.94	7.85	.41	2	.0
IR-19	42 28 32	107 11 47	1.42	9.20	4.04	6.48	2.28	.35	6	.0
IR-20	42 29 3	107 12 42	.96	4.60	2.75	4.79	1.67	.35	4	.0
IR-21	42 27 6	107 12 23	.96	4.60	2.75	4.79	1.67	.35	2	.0
IR-22	42 28 50	107 14 24	1.07	12.00	2.91	11.21	4.12	.37	2	.0
IR-23	42 29 25	107 14 9	1.11	44.50	4.57	40.09	9.74	.24	2	.0
IR-24	42 28 16	107 14 3	.55	6.40	4.11	11.64	1.56	.13	6	.0
IR-25	42 28 24	107 13 10	.81	3.90	2.74	4.81	1.42	.30	4	.0
IR-26	42 26 44	107 13 47	.98	10.60	3.70	10.82	2.86	.26	6	.0
IR-27	42 27 16	107 8 19	1.14	24.80	3.45	21.75	7.19	.33	2	.0
IR-28	42 28 56	107 7 56	1.70	42.80	3.91	25.18	10.95	.43	2	.0
JC-1	42 29 55	107 46 39	1.90	12.40	4.32	6.53	2.87	.44	6	.0
JC-2	42 29 55	107 47 21	23.60	42.30	1.27	1.79	33.31	18.58	7	.0

Table 1.- Radioelement contents and ratios for Archean granitic rocks of central Wyoming--continued

Sample	Latitude	Longitude	RaeU ppm	Th ppm	K (wt %)	Th/RaeU	Th/K*	RaeU/K*	Type†	Depth m
JC-3	42 29 55	107 47 21	3.00	26.20	3.51	8.73	7.46	.85	2	.0
L-1	42 22 7	106 48 28	1.49	42.20	4.50	28.32	9.38	.33	2	.0
L-2	42 21 41	106 48 59	3.58	77.60	4.51	21.68	17.21	.79	2	.0
L-3	42 20 14	106 50 48	2.23	15.00	4.13	6.73	3.63	.54	6	.0
L-4	42 19 5	106 49 5	2.02	37.80	4.44	18.71	8.51	.45	2	.0
L-5	42 20 7	106 48 52	5.92	54.50	4.17	9.21	13.07	1.42	2	.0
L-6	42 20 33	106 50 15	5.40	133.00	4.18	24.63	31.82	1.29	2	.0
L-7	42 20 47	106 49 29	2.09	32.00	4.44	15.31	7.21	.47	2	.0
L-8	42 21 11	106 48 5	68.30	88.80	4.16	1.30	21.35	16.42	4	.0
L-9	42 21 42	106 46 50	5.68	96.00	5.33	16.90	18.01	1.07	2	.0
L-10	42 22 12	106 46 17	10.90	69.40	3.73	6.37	18.61	2.92	2	.0
L-11	42 16 52	106 51 15	1.51	12.50	2.83	8.28	4.42	.53	2	.0
L-12	42 16 56	106 51 11	2.23	47.80	.22	21.43	217.27	10.14	7	.0
L-13	42 17 10	106 50 28	1.87	108.00	4.70	57.75	22.98	.40	2	.0
L-14	42 17 0	106 48 24	1.65	52.70	4.29	31.94	12.28	.38	2	.0
L-15	42 17 28	106 48 5	1.78	77.60	4.53	43.60	17.13	.39	2	.0
L-16	42 18 16	106 46 51	1.58	77.60	4.51	49.11	17.21	.35	2	.0
L-17	42 19 12	106 45 59	.93	78.80	4.78	84.73	16.49	.19	2	.0
L-18	42 19 12	106 47 3	7.42	159.00	.28	21.43	567.86	26.50	7	.0
L-19	42 19 12	106 47 3	2.32	43.00	4.29	18.53	10.02	.54	2	.0
L-20	42 18 43	106 47 55	1.95	62.40	4.33	32.00	14.41	.45	2	.0
L-21	42 18 31	106 48 40	6.81	98.20	4.44	14.42	22.12	1.53	2	.0
L-22	42 18 18	106 49 47	2.03	8.77	4.87	4.32	1.80	.42	6	.0
L-23	42 18 55	106 49 46	5.98	69.40	4.47	11.61	15.53	1.34	2	.0
L-24	42 19 1	106 50 40	3.96	27.20	3.93	6.87	6.92	1.01	2	.0
L-25	42 19 17	106 51 22	7.53	76.50	4.75	10.16	16.11	1.59	2	.0
L-26	42 19 51	106 51 17	9.13	79.40	4.54	8.70	17.49	2.01	2	.0
L-27	42 20 9	106 49 41	1.10	12.80	4.42	11.64	2.90	.25	6	.0
L-28	42 20 32	106 48 3	3.34	44.40	4.32	13.29	10.28	.77	2	.0
L-29	42 20 30	106 47 0	4.75	105.00	3.89	22.11	26.99	1.22	2	.0
L-30	42 20 36	106 45 43	5.33	47.60	4.72	8.93	10.08	1.13	2	.0
L-31	42 21 55	106 45 10	4.10	54.30	4.79	13.24	11.34	.86	2	.0
L-33	42 19 39	106 51 44	26.70	31.80	.35	1.19	90.86	76.29	7	.0
L-34	42 22 8	106 52 8	3.32	45.80	4.06	13.80	11.28	.82	2	.0
L-35	42 18 14	106 46 28	1.67	17.90	3.90	10.72	4.59	.43	2	.0
L-36	42 17 46	106 46 27	1.00	20.00	4.19	20.00	4.77	.24	2	.0
L-37	42 17 18	106 46 19	1.40	81.90	4.28	58.50	19.14	.33	2	.0
L-38	42 17 49	106 50 59	2.15	9.29	.83	4.32	11.19	2.59	7	.0
L-39	42 18 30	106 50 40	10.40	3.20	1.63	.31	1.96	6.38	2	.0
L-PM1-1	42 22 7	106 45 29	13.50	38.00	4.86	2.81	7.82	2.78	2	40.4
L-PM2-1	42 21 2	106 48 25	6.05	52.05	4.14	8.60	12.57	1.46	2	57.2
L-PM3-1	42 21 54	106 46 14	19.70	42.40	4.28	2.15	9.91	4.60	2	66.3
LD-1	42 34 44	107 36 56	11.90	38.40	.06	3.23	640.00	198.33	7	.0
LD-3	42 33 54	107 35 48	3.36	38.80	4.63	11.55	8.38	.73	2	.0
LD-4	42 33 23	107 35 52	21.50	50.80	4.18	2.36	12.15	5.14	2	.0

Table 1.- Radioelement contents and ratios for Archean granitic rocks of central Wyoming--continued

Sample	Latitude	Longitude	RaeU ppm	Th ppm	K (wt %)	Th/RaeU	Th/K*	RaeU/K*	Type†	Depth m
LD-5	42 32 26	107 35 51	10.40	59.80	5.94	5.75	10.07	1.75	2	.0
LD-6	42 32 16	107 34 56	3.13	34.40	3.98	10.99	8.64	.79	2	.0
LD-7	42 32 10	107 34 9	1.59	9.46	4.10	5.95	2.31	.39	6	.0
LD-8	42 32 52	107 33 11	2.11	29.70	4.43	14.08	6.70	.48	2	.0
LD-9	42 32 19	107 32 38	3.06	18.60	3.86	6.08	4.82	.79	6	.0
LD-10	42 31 16	107 33 27	3.89	40.60	4.46	10.44	9.10	.87	2	.0
LD-11	42 31 44	107 32 15	1.45	10.00	3.59	6.90	2.79	.40	6	.0
LD-12	42 32 13	107 31 3	2.56	11.70	4.12	4.57	2.84	.62	6	.0
LD-13	42 31 45	107 30 37	5.39	69.10	4.42	12.82	15.63	1.22	2	.0
LD-14	42 30 29	107 30 1	3.15	31.90	4.64	10.13	6.88	.68	2	.0
LD-15	42 32 28	107 36 54	3.40	24.60	4.40	7.24	5.59	.77	2	.0
LD-16	42 31 8	107 34 47	3.40	58.20	4.77	17.12	12.20	.71	2	.0
LD-17	42 31 8	107 34 47	4.70	72.50	.67	15.43	108.21	7.01	7	.0
LD-18	42 30 27	107 33 40	2.90	44.50	4.68	15.34	9.51	.62	2	.0
LD-19	42 30 34	107 32 41	4.80	69.60	4.29	14.50	16.22	1.12	2	.0
LD-DDH8	42 34 47	107 36 45	6.91	34.60	4.53	5.01	7.64	1.53	2	.9
LM-2	42 35 38	107 29 36	9.60	7.54	.09	.79	83.78	106.67	7	.0
LM-3	42 32 32	107 25 51	1.87	35.80	3.99	19.14	8.97	.47	2	.0
LM-4	42 32 42	107 26 39	2.64	45.00	4.72	17.05	9.53	.56	2	.0
LM-5	42 33 26	107 27 2	1.52	6.20	5.04	4.08	1.23	.30	6	.0
LM-6	42 34 13	107 29 9	2.92	30.80	4.48	10.55	6.87	.65	2	.0
LM-7	42 34 54	107 28 39	3.62	30.80	4.50	8.51	6.84	.80	2	.0
LM-8	42 33 47	107 26 14	3.00	38.70	4.38	12.90	8.84	.68	2	.0
LM-9	42 33 10	107 23 18	1.76	32.10	3.94	18.24	8.15	.45	2	.0
LM-10	42 31 56	107 25 6	1.93	31.50	4.38	16.32	7.19	.44	2	.0
LM-11	42 30 21	107 29 5	2.60	62.70	4.77	24.12	13.14	.55	2	.0
LM-12	42 30 21	107 26 26	1.00	41.10	3.46	41.10	11.88	.29	2	.0
LM-13	42 31 7	107 26 0	1.20	29.30	3.33	24.42	8.80	.36	2	.0
LM-14	42 31 22	107 27 15	1.30	38.60	3.51	29.69	11.00	.37	2	.0
LM-15	42 33 17	107 28 1	4.30	8.70	4.43	2.02	1.96	.97	6	.0
LM-16	42 32 27	107 27 53	3.00	49.40	4.57	16.47	10.81	.66	2	.0
LM-17	42 31 43	107 29 15	4.50	57.40	4.20	12.76	13.67	1.07	2	.0
LM-18	42 32 26	107 29 53	2.10	7.27	3.52	3.46	2.07	.60	6	.0
LM-19	42 32 26	107 29 53	1.90	12.80	4.13	6.74	3.10	.46	6	.0
LM-20	42 35 19	107 23 7	1.84	14.50	3.93	7.88	3.69	.47	6	.0
LM-21	42 35 19	107 23 7	3.00	21.50	4.10	7.17	5.24	.73	6	.0
LM-22	42 33 49	107 24 7	2.50	44.60	4.88	17.84	9.14	.51	2	.0
LM-23	42 32 21	107 24 29	7.30	61.90	4.64	8.48	13.34	1.57	2	.0
LM-24	42 32 23	107 22 58	3.40	56.70	4.17	16.68	13.60	.82	2	.0
LM-25	42 31 0	107 22 51	1.40	21.60	4.44	15.43	4.86	.32	6	.0
MS-1	42 33 46	107 22 12	13.00	43.90	.06	3.38	731.67	216.67	7	.0
MS-2	42 35 48	107 20 11	.51	3.51	5.31	6.88	.66	.10	6	.0
MS-5	42 39 15	107 19 12	1.39	29.30	4.16	21.08	7.04	.33	2	.0
MS-6	42 32 24	107 20 43	7.12	27.20	.68	3.82	40.00	10.47	7	.0
MS-9	42 36 1	107 21 39	4.78	32.80	2.45	6.86	13.39	1.95	2	.0

Table 1.- Radioelement contents and ratios for Archean granitic rocks of central Wyoming--continued

Sample	Latitude	Longitude	RaeU ppm	Th ppm	K (wt %)	Th/RaeU	Th/K*	RaeU/K*	Type†	Depth m
MS-10	42 34 30	107 21 46	2.75	44.40	4.65	16.15	9.55	.59	2	.0
MS-11	42 32 9	107 21 33	6.90	57.00	4.50	8.26	12.67	1.53	2	.0
MS-12	42 31 51	107 20 53	3.30	69.10	4.67	20.94	14.80	.71	2	.0
MS-13	42 31 26	107 21 44	3.20	23.90	3.82	7.47	6.26	.84	2	.0
MS-14	42 30 35	107 22 30	1.60	30.60	4.10	19.13	7.46	.39	2	.0
MS-15	42 30 51	107 20 27	5.40	51.60	.14	9.56	368.57	38.57	7	.0
MS-16	42 30 51	107 20 27	1.70	59.10	4.15	34.76	14.24	.41	2	.0
MS-17	42 31 10	107 19 12	1.60	18.60	3.10	11.63	6.00	.52	2	.0
MS-18	42 32 30	107 18 56	4.60	28.50	4.70	6.20	6.06	.98	2	.0
MS-19	42 32 8	107 17 58	2.90	40.60	4.28	14.00	9.49	.68	2	.0
MS-20	42 30 23	107 16 8	1.00	122.00	3.99	122.00	30.58	.25	2	.0
MS-21	42 30 22	107 17 18	.84	7.65	4.04	9.11	1.89	.21	6	.0
MS-22	42 30 54	107 16 42	1.00	4.60	4.42	4.60	1.04	.23	6	.0
MS-23	42 30 57	107 18 20	1.10	18.10	4.24	16.45	4.27	.26	6	.0
MS-24	42 31 38	107 16 45	6.10	32.30	4.24	5.30	7.62	1.44	2	.0
MS-25	42 31 53	107 15 47	1.80	31.90	4.34	17.72	7.35	.41	2	.0
MS-26	42 32 46	107 16 3	1.80	14.90	2.76	8.28	5.40	.65	4	.0
MS-27	42 33 24	107 14 54	3.50	41.50	4.35	11.86	9.54	.80	2	.0
MS-28	42 33 1	107 17 3	2.10	24.50	4.41	11.67	5.56	.48	2	.0
MS-29	42 33 34	107 16 10	2.80	19.30	4.12	6.89	4.68	.68	2	.0
MS-30	42 34 20	107 15 27	2.30	38.90	4.45	16.91	8.74	.52	2	.0
MS-31	42 36 23	107 15 28	4.00	17.10	4.11	4.27	4.16	.97	6	.0
MS-32	42 35 12	107 15 57	2.70	20.40	4.56	7.56	4.47	.59	2	.0
MS-CR1-1	42 41 53	107 19 44	3.73	36.70	3.75	9.84	9.79	.99	2	30.2
MS-CR2-1	42 33 46	107 22 12	3.75	41.80	4.86	11.15	8.60	.77	2	50.3
PD-1	42 24 1	106 45 5	4.70	39.50	4.72	8.40	8.37	1.00	2	.0
PD-2	42 23 17	106 45 47	3.19	9.60	3.87	3.01	2.48	.82	6	.0
PD-3	42 23 15	106 45 31	6.64	60.80	4.82	9.16	12.61	1.38	2	.0
PD-4	42 22 37	106 47 5	--	77.00	--	--	--	--	7	.0
PD-5	42 22 37	106 47 5	6.92	68.50	4.44	9.90	15.43	1.56	2	.0
PD-6	42 22 35	106 47 49	3.82	58.70	4.74	15.37	12.38	.81	2	.0
PD-7	42 23 12	106 48 24	23.80	31.90	4.80	1.34	6.65	4.96	2	.0
PD-8	42 23 32	106 49 40	3.25	101.00	4.94	31.08	20.45	.66	2	.0
PD-9	42 22 51	106 49 58	2.72	62.40	4.47	22.94	13.96	.61	2	.0
PD-10	42 23 42	106 51 19	2.00	17.60	4.53	8.80	3.89	.44	6	.0
PD-11	42 23 15	106 52 17	2.40	35.10	4.21	14.62	8.34	.57	2	.0
PD-12	42 22 34	106 51 8	5.00	92.00	4.35	18.40	21.15	1.15	2	.0
PD-13	42 29 8	106 50 0	2.50	14.50	4.94	5.80	2.94	.51	4	.0
PD-14	42 28 10	106 52 21	2.40	35.00	4.43	14.58	7.90	.54	2	.0
PD-15	42 28 14	106 51 9	4.20	41.00	4.27	9.76	9.60	.98	2	.0
PD-16	42 28 0	106 50 5	4.10	25.10	4.22	6.12	5.95	.97	2	.0
PD-17	42 28 28	106 47 37	3.50	23.30	3.69	6.66	6.31	.95	2	.0
PD-18	42 28 29	106 48 52	5.00	32.90	4.74	6.58	6.94	1.05	2	.0
PD-19	42 27 39	106 46 49	5.30	47.10	4.07	8.89	11.57	1.30	2	.0
PD-20	42 26 30	106 47 18	4.60	57.60	4.29	12.52	13.43	1.07	2	.0

Table 1.- Radioelement contents and ratios for Archean granitic rocks of central Wyoming--continued

Sample	Latitude	Longitude	RaeU ppm	Th ppm	K (wt %)	Th/RaeU	Th/K*	RaeU/K*	Type†	Depth m
PD-21	42 25 51	106 47 45	8.00	40.10	3.84	5.01	10.44	2.08	2	.0
PD-22	42 27 15	106 48 15	3.80	48.60	4.60	12.79	10.57	.83	2	.0
PD-23	42 26 46	106 48 38	3.00	38.70	4.53	12.90	8.54	.66	2	.0
PD-24	42 25 55	106 49 10	3.10	46.70	3.03	15.06	15.41	1.02	2	.0
PD-25	42 25 11	106 47 35	2.00	39.50	5.22	19.75	7.57	.38	2	.0
PD-26	42 24 53	106 49 44	2.30	52.00	4.94	22.61	10.53	.47	2	.0
PD-27	42 25 23	106 50 22	3.90	47.20	3.10	12.10	15.23	1.26	4	.0
PD-28	42 25 23	106 50 22	4.40	72.00	3.63	16.36	19.83	1.21	2	.0
PRNW-2	42 26 53	106 58 54	2.20	78.80	4.27	35.82	18.45	.52	2	.0
PRNW-3	42 23 44	106 54 18	2.60	30.70	3.71	11.81	8.27	.70	2	.0
PRNW-4	42 28 50	106 59 22	3.60	60.20	4.78	16.72	12.59	.75	2	.0
PRNW-5	42 25 55	106 58 40	5.00	112.00	.06	22.40	1,866.67	83.33	7	.0
PRNW-6	42 27 26	106 56 29	2.50	75.90	3.82	30.36	19.87	.65	2	.0
PRNW-7	42 27 18	106 57 44	4.20	70.40	4.63	16.76	15.21	.91	2	.0
PRNW-8	42 28 11	106 55 16	2.90	34.80	4.02	12.00	8.66	.72	2	.0
PRNW-9	42 27 40	106 59 20	3.40	63.40	4.57	18.65	13.87	.74	2	.0
PRNW-10	42 27 44	106 58 11	2.50	52.00	4.44	20.80	11.71	.56	6	.0
PRNW-11	42 28 18	106 56 21	7.50	31.50	2.69	4.20	11.71	2.79	2	.0
PRNW-12	42 28 54	106 55 31	11.40	51.70	.10	4.54	517.00	114.00	7	.0
PRNW-13	42 25 13	106 52 55	1.60	55.00	4.22	34.38	13.03	.38	2	.0
PRSW-1	42 20 44	106 54 29	1.15	12.90	4.39	11.22	2.94	.26	6	.0
PRSW-2	42 20 4	106 54 48	.53	38.40	3.99	72.45	9.62	.13	2	.0
PRSW-3	42 19 36	106 54 9	.48	8.15	3.91	16.98	2.08	.12	4	.0
PRSW-4	42 19 9	106 54 21	.53	19.10	3.55	36.04	5.38	.15	2	.0
PRSW-5	42 18 39	106 52 24	2.99	25.30	.39	8.46	64.87	7.67	7	.0
PRSW-6	42 18 33	106 53 42	1.89	67.80	4.69	35.87	14.46	.40	2	.0
PRSW-7	42 17 55	106 54 33	.96	62.90	4.16	65.52	15.12	.23	2	.0
PRSW-9	42 17 59	106 53 20	1.29	52.70	4.28	40.85	12.31	.30	2	.0
PRSW-10	42 17 25	106 53 7	2.39	58.20	4.41	24.35	13.20	.54	2	.0
PRSW-11	42 21 8	106 52 32	8.30	76.00	4.56	9.16	16.67	1.82	2	.0
PRSW-12	42 21 44	106 59 33	2.00	33.80	4.10	16.90	8.24	.49	2	.0
PRSW-13	42 22 24	106 55 11	4.50	40.60	4.41	9.02	9.21	1.02	2	.0
PRSW-14	42 21 24	106 55 48	1.20	23.70	2.72	19.75	8.71	.44	2	.0
PRSW-15	42 20 33	106 57 6	2.00	44.70	3.81	22.35	11.73	.52	2	.0
PRSW-16	42 22 28	106 52 44	3.40	43.60	3.83	12.82	11.38	.89	2	.0
SD-1	42 9 46	106 55 44	2.63	30.20	3.42	11.48	8.83	.77	2	.0
SD-2	42 10 11	106 56 30	1.74	18.70	2.69	10.75	6.95	.65	7	.0
SD-3	42 10 32	106 55 47	1.89	11.20	1.89	5.93	5.93	1.00	7	.0
SD-4	42 10 55	106 54 57	1.73	24.50	3.66	14.16	6.69	.47	4	.0
SD-6	42 11 4	106 54 3	2.28	15.10	3.43	6.62	4.40	.66	4	.0
SD-7	42 11 5	106 53 49	2.64	23.30	3.39	8.83	6.87	.78	4	.0
SD-8	42 13 31	106 53 49	4.16	35.60	.10	8.56	356.00	41.60	7	.0
SD-9	42 13 34	106 53 47	1.74	23.80	1.78	13.68	13.37	.98	7	.0
SD-10	42 13 50	106 53 3	1.38	78.70	3.80	57.03	20.71	.36	2	.0
SD-11	42 13 32	106 52 53	1.77	29.20	3.09	16.50	9.45	.57	2	.0

Table 1.- Radioelement contents and ratios for Archean granitic rocks of central Wyoming--continued

Sample	Latitude	Longitude	RaeU ppm	Th ppm	K (wt %)	Th/RaeU	Th/K*	RaeU/K*	Type†	Depth m
SD-12	42 14 12	106 52 41	1.49	59.20	3.61	39.73	16.40	.41	2	.0
SD-13	42 14 26	106 53 8	1.62	29.60	4.28	18.27	6.92	.38	2	.0
SD-15	42 9 34	106 54 33	3.48	29.40	1.93	8.45	15.23	1.80	4	.0
SD-16	42 10 29	106 52 32	3.18	26.90	3.66	8.46	7.35	.87	2	.0
SD-17	42 9 34	106 54 55	1.59	14.40	4.03	9.06	3.57	.39	6	.0
SM-1	42 30 21	107 48 43	5.27	57.30	4.16	10.87	13.77	1.27	2	.0
SM-2	42 31 19	107 46 54	3.20	30.60	4.93	9.56	6.21	.65	2	.0
SM-3	42 31 26	107 45 54	5.86	39.90	4.12	6.81	9.68	1.42	2	.0
SM-4	42 31 26	107 45 54	10.70	62.00	4.26	5.79	14.55	2.51	2	.0
SM-5	42 32 43	107 44 51	8.92	47.50	.07	5.33	678.57	127.43	7	.0
SM-6	42 31 29	107 51 44	2.10	31.70	3.72	15.10	8.52	.56	2	.0
SM-7	42 32 2	107 51 8	1.70	42.60	3.87	25.06	11.01	.44	2	.0
SM-8	42 31 51	107 49 49	1.90	29.30	2.84	15.42	10.32	.67	7	.0
SM-9	42 30 0	106 58 0	2.60	27.30	2.70	10.50	10.11	.96	7	.0
SM-10	42 32 7	107 46 35	2.50	38.90	4.46	15.56	8.72	.56	2	.0
SM-11	42 32 7	107 46 35	5.70	30.60	.29	5.37	105.52	19.66	7	.0
SM-12	42 31 1	107 47 55	3.10	24.20	3.61	7.81	6.70	.86	2	.0
SM-13	42 30 22	107 46 15	3.70	54.80	4.39	14.81	12.48	.84	2	.0
SM-DDH6A	42 32 53	107 49 22	2.05	21.70	3.59	10.59	6.04	.57	2	1.2
SM-DDH6B	42 32 53	107 49 22	2.07	23.90	3.96	11.55	6.04	.52	2	.9
SDNE-2	42 13 59	106 49 21	1.25	30.00	3.45	24.00	8.70	.36	2	.0
SDNE-3	42 14 5	106 48 16	.55	27.50	4.21	50.00	6.53	.13	2	.0
SDNE-4	42 14 36	106 49 59	2.27	45.40	3.49	20.00	13.01	.65	2	.0
SDNE-5	42 12 58	106 49 18	2.01	24.70	5.85	12.29	4.22	.34	2	.0
SDNE-6	42 13 31	106 49 8	2.47	42.90	3.40	17.37	12.62	.73	2	.0
SDNE-7	42 11 30	106 51 49	4.44	67.30	3.76	15.16	17.90	1.18	2	.0
SDNE-8	42 14 47	106 51 59	2.82	21.10	3.02	7.48	6.99	.93	2	.0
SDNE-9	42 13 57	106 46 35	1.90	14.80	4.30	7.79	3.44	.44	6	.0
SDNE-10	42 13 49	106 47 18	3.44	21.90	4.70	6.37	4.66	.73	2	.0
SDNE-11	42 13 7	106 51 17	11.50	26.10	.16	2.27	163.13	71.88	7	.0
SDNE-12	42 11 39	106 50 59	1.59	11.90	5.22	7.48	2.28	.30	6	.0
SDNE-13	42 12 5	106 51 12	2.00	39.80	4.41	19.90	9.02	.45	2	.0
SDNE-14	42 12 17	106 50 25	1.21	13.00	4.25	10.74	3.06	.28	6	.0
SDNE-16	42 12 31	106 49 53	1.16	11.90	3.36	10.26	3.54	.35	6	.0
SP-1	42 28 45	107 19 50	1.20	15.90	3.17	13.25	5.02	.38	4	.0
SP-2	42 29 23	107 19 5	1.35	32.80	3.61	24.30	9.09	.37	2	.0
SP-3	42 29 23	107 19 5	3.09	43.00	5.53	13.92	7.78	.56	2	.0
SP-4	42 29 22	107 18 4	.93	23.80	2.74	25.59	8.69	.34	2	.0
SP-5	42 27 51	107 19 28	.54	18.50	2.98	34.26	6.21	.18	4	.0
SP-6	42 27 45	107 18 36	1.03	9.61	3.44	9.33	2.79	.30	4	.0
SP-7	42 28 46	107 15 20	1.20	92.00	2.24	76.67	41.07	.54	4	.0
SP-8	42 29 46	107 20 27	1.00	23.50	3.95	23.50	5.95	.25	6	.0
SP-9	42 29 46	107 20 30	2.30	19.40	1.51	8.43	12.85	1.52	4	.0
SP-10	42 29 53	107 16 27	.90	47.90	3.90	53.22	12.28	.23	2	.0
SR-1	42 28 49	107 30 50	2.90	68.40	4.52	23.59	15.13	.64	2	.0

Table 1.- Radioelement contents and ratios for Archean granitic rocks of central Wyoming--continued

Sample	Latitude	Longitude	RaeU ppm	Th ppm	K (wt %)	Th/RaeU	Th/K*	RaeU/K*	Type†	Depth m
SR-2	42 29 45	107 30 19	3.00	46.00	4.43	15.33	10.38	.68	2	.0
SR-3	42 29 1	107 34 16	2.50	48.80	4.19	19.52	11.65	.60	2	.0
SR-4	42 29 7	107 33 8	2.50	26.40	4.57	10.56	5.78	.55	2	.0
SR-5	42 29 15	107 32 14	3.50	58.70	4.33	16.77	13.56	.81	2	.0
SR-6	42 28 2	107 33 16	3.50	57.20	4.16	16.34	13.75	.84	2	.0
SR-7	42 28 8	107 34 15	2.20	50.30	4.43	22.86	11.35	.50	2	.0
SR-8	42 29 33	107 33 39	1.70	18.00	4.09	10.59	4.40	.42	6	.0
SR-9	42 29 44	107 32 45	4.60	53.00	4.34	11.52	12.21	1.06	2	.0
SR-10	42 27 16	107 32 31	3.00	56.10	4.28	18.70	13.11	.70	2	.0
SRNW-1	42 29 44	107 40 23	4.70	50.30	4.39	10.70	11.46	1.07	2	.0
SRNW-2	42 29 44	107 40 23	2.50	92.80	4.14	37.12	22.42	.60	2	.0
SRNW-3	42 29 59	107 38 45	5.10	62.50	4.13	12.25	15.13	1.23	2	.0
SRQ-1	42 30 24	107 3 18	3.10	56.00	4.25	18.06	13.18	.73	2	.0
SRQ-3	42 30 41	107 2 12	3.40	51.20	4.59	15.06	11.15	.74	2	.0
SRQ-4	42 32 23	107 0 52	8.50	9.40	.10	1.11	94.00	85.00	7	.0
SRQ-5	42 31 55	107 0 30	6.40	47.50	4.69	7.42	10.13	1.36	2	.0
SRQ-6	42 31 23	107 1 19	7.90	61.00	4.03	7.72	15.14	1.96	2	.0
SRQ-7	42 33 22	107 0 57	7.90	54.40	.11	6.89	494.55	71.82	7	.0
TCM-2	42 40 58	107 59 0	2.97	19.70	2.78	6.63	7.09	1.07	2	.0
TCM-1686	42 39 0	107 54 23	2.14	27.70	3.73	12.94	7.43	.57	2	.0
TCM-DDH3	42 38 24	107 57 6	1.56	11.50	5.50	7.37	2.09	.28	6	5.5
TCM-DDH4	42 40 40	107 58 52	2.14	19.30	2.27	9.02	8.50	.94	2	.9
TCM-DDH5	42 38 13	107 57 13	1.98	26.00	4.12	13.13	6.31	.48	2	.9
LG-1	42 25 34	105 18 0	1.61	8.89	3.99	5.52	2.23	.40	2	.0
LG-2	42 21 38	105 26 13	3.55	31.70	3.78	8.93	8.39	.94	2	.0
LG-3	42 20 47	105 27 5	9.75	116.00	4.39	11.90	26.42	2.22	2	.0
LG-4	42 18 18	105 30 46	1.57	18.50	3.70	11.78	5.00	.42	2	.0
LG-5	42 15 21	105 28 57	2.09	27.60	3.78	13.21	7.30	.55	2	.0
LG-6	42 12 48	105 31 16	1.84	76.20	3.94	41.41	19.34	.47	2	.0
LG-7	42 10 12	105 33 0	4.52	10.70	5.19	2.37	2.06	.87	6	.0
LG-8	42 10 12	105 33 0	3.06	98.00	4.22	32.03	23.22	.73	2	.0
LG-9	42 7 43	105 36 59	2.30	32.10	3.79	13.96	8.47	.61	2	.0
LG-10	42 13 18	105 19 53	1.70	39.70	3.79	23.35	10.47	.45	2	.0
LG-11	42 14 49	105 23 20	1.15	27.70	3.58	24.09	7.74	.32	2	.0
LG-12	42 17 5	105 21 7	1.60	22.10	2.21	13.81	10.00	.72	4	.0
LG-13	42 18 53	105 22 19	2.24	21.50	3.17	9.60	6.78	.71	2	.0
LG-14	42 15 53	105 32 27	1.41	15.80	3.94	11.21	4.01	.36	2	.0
LG-15	42 14 8	105 37 24	6.05	64.00	3.64	10.58	17.58	1.66	2	.0
LG-16	42 11 47	105 39 51	6.57	64.30	4.41	9.79	14.58	1.49	2	.0
LG-17	42 15 18	105 43 43	11.80	58.30	4.55	4.94	12.81	2.59	2	.0
LG-18	42 18 40	105 39 22	4.10	23.90	3.11	5.83	7.68	1.32	2	.0
LG-19	42 22 5	105 41 50	1.73	16.50	3.15	9.54	5.24	.55	2	.0
LG-20	42 24 26	105 37 31	2.03	19.20	3.40	9.46	5.65	.60	2	.0
LG-21	42 28 50	105 42 8	1.26	12.20	3.66	9.68	3.33	.34	2	.0
LG-22	42 37 9	105 40 51	4.99	17.50	4.10	3.51	4.27	1.22	2	.0

Table 1.- Radioelement contents and ratios for Archean granitic rocks of central Wyoming--continued

Sample	Latitude	Longitude	RaeU ppm	Th ppm	K (wt %)	Th/RaeU	Th/K*	RaeU/K*	Type†	Depth m
LG-23	42 26 39	105 27 36	6.74	34.50	2.31	5.12	14.94	2.92	4	.0
LG-24	42 23 43	105 28 37	5.22	61.80	4.44	11.84	13.92	1.18	2	.0
LG-25	42 27 50	105 22 41	3.61	8.57	3.14	2.37	2.73	1.15	6	.0
LG-26	42 31 45	105 42 58	2.29	20.20	2.78	8.82	7.27	.82	7	.0
LG-27	42 30 10	105 47 49	21.70	144.50	.33	6.66	437.88	65.76	7	.0
LG-28	42 25 58	105 54 37	3.70	53.80	4.28	14.54	12.57	.86	2	.0
LG-29	42 27 42	105 58 31	6.70	39.40	4.25	5.88	9.27	1.58	2	.0
LG-30	42 30 17	106 4 50	6.55	73.20	4.66	11.18	15.71	1.41	2	.0
LG-31	42 31 27	105 57 21	6.27	77.50	4.51	12.36	17.18	1.39	2	.0
LG-32	42 33 50	105 55 5	5.12	30.90	.66	6.04	46.82	7.76	7	.0
LG-33	42 36 18	105 52 39	9.73	19.20	.27	1.97	71.11	36.04	7	.0
LG-34	42 36 18	105 52 39	6.77	16.20	3.72	2.39	4.35	1.82	2	.0
LG-35	42 39 8	105 56 6	3.72	13.00	3.14	3.49	4.14	1.18	2	.0
LG-36	42 38 55	106 1 13	2.49	23.10	4.20	9.28	5.50	.59	2	.0
LG-37	42 46 0	106 20 0	3.69	15.00	3.59	4.07	4.18	1.03	2	.0
NH-1-73	42 21 13	105 40 50	18.73	79.19	--	4.23	--	--	2	.0
NH-2-73	42 21 13	105 40 50	8.67	35.94	--	4.15	--	--	2	.0
NH-3-73	42 22 25	105 41 42	1.80	18.37	--	10.21	--	--	2	.0
NH-4-73	42 22 25	105 41 42	1.92	11.53	--	6.01	--	--	2	.0
NH-5-73	42 22 15	105 41 40	2.50	15.42	--	6.17	--	--	2	.0
NH-6-73	42 21 15	105 41 44	3.04	52.68	--	17.33	--	--	2	.0
SB-88H60	42 41 44	105 48 37	1.73	9.04	--	5.23	--	--	2	.0
SB-89H60	42 25 2	105 44 52	5.90	39.72	--	6.73	--	--	2	.0
HU-1	42 37 0	104 28 0	11.50	50.60	4.95	4.40	10.22	2.32	2	.0
HU-2	42 36 0	104 30 0	2.40	33.20	5.90	13.83	5.63	.41	2	.0
HU-3	42 37 0	104 34 0	3.60	36.50	3.81	10.14	9.58	.94	2	.0
HU-20	42 40 0	104 29 0	2.20	26.80	5.69	12.18	4.71	.39	2	.0
HU-21	42 36 0	104 29 0	4.30	53.40	4.00	12.42	13.35	1.08	2	.0
HU-26	42 37 0	104 30 0	6.40	49.70	4.85	7.77	10.25	1.32	2	.0
HU-27A	42 37 0	104 30 0	2.70	48.00	4.75	17.78	10.11	.57	2	.0
HU-27B	42 37 0	104 30 0	1.00	7.70	4.85	7.70	1.59	.21	6	.0
HU-5	42 16 0	104 42 0	12.00	37.30	4.05	3.11	9.21	2.96	2	.0
HU-32	42 24 0	104 38 0	6.70	68.60	4.85	10.24	14.14	1.38	2	.0
HU-14	42 26 0	104 55 0	9.90	27.40	4.23	2.77	6.48	2.34	2	.0
HU-15	42 26 0	104 55 0	5.20	51.80	4.19	9.96	12.36	1.24	2	.0
71TDG6	43 24 24	107 51 31	.30	2.20	7.46	7.33	.29	.04	6	.0
71TDG12	43 25 28	107 50 29	11.80	31.40	4.00	2.66	7.85	2.95	2	.0
71TDG13	43 26 15	107 51 2	2.90	49.80	4.31	17.17	11.55	.67	2	.0
71TDG16	43 27 39	108 10 12	3.90	4.72	3.05	1.21	1.55	1.28	6	.0
71TDG20	43 26 49	108 4 51	1.90	7.60	3.91	4.00	1.94	.49	2	.0
71TDG21	43 26 50	108 1 50	2.40	50.30	4.38	20.96	11.48	.55	2	.0
71TDG22	43 29 1	108 0 58	2.80	47.00	4.76	16.79	9.87	.59	2	.0
71TDG24	43 27 53	108 10 12	5.60	17.40	3.93	3.11	4.43	1.42	2	.0
72TDG44	43 24 46	107 52 29	10.80	29.70	5.82	2.75	5.10	1.86	2	.0
72TDG45	43 24 46	107 52 29	2.68	2.56	3.47	.96	.74	.77	4	56.8

Table 1.- Radioelement contents and ratios for Archean granitic rocks of central Wyoming--continued

Sample	Latitude	Longitude	RaeU ppm	Th ppm	K (wt %)	Th/RaeU	Th/K*	RaeU/K*	Type†	Depth m
72TDG46	43 24 17	107 52 21	69.30	23.60	3.30	.34	7.15	21.00	2	81.5
72TDG47	43 24 17	107 52 21	75.30	31.50	2.80	.42	11.25	26.89	2	115.9
DP-1	43 26 0	107 50 30	3.16	9.14	3.83	2.89	2.39	.83	6	.0
DP-2	43 23 20	107 51 30	14.30	27.00	3.66	1.89	7.38	3.91	2	.0
DP-3	43 24 30	107 52 32	3.70	38.70	3.32	10.46	11.66	1.11	2	.0
DP-8	43 23 15	107 50 0	3.40	24.70	3.43	7.26	7.20	.99	2	.0
GP-1	43 24 15	107 59 57	.98	5.21	1.86	5.32	2.80	.53	4	.0
GP-2	43 25 3	107 58 30	.50	2.84	.14	5.68	20.29	3.57	7	.0
GP-3	43 24 12	107 57 30	9.30	44.40	6.34	4.77	7.00	1.47	2	.0
GP-4	43 24 0	107 55 30	16.50	38.40	.14	2.33	274.29	117.86	7	.0
GP-5	43 24 45	107 52 32	2.66	17.70	3.98	6.65	4.45	.67	6	.0
29-394	43 24 31	107 52 30	12.70	40.50	2.56	3.19	15.82	4.96	2	120.1
29-467	43 24 31	107 52 30	8.28	26.00	3.12	3.14	8.33	2.65	2	142.3
58-66	43 24 32	107 52 27	11.50	34.70	4.26	3.02	8.15	2.70	2	20.1
58-80	43 24 32	107 52 27	12.30	31.30	3.92	2.54	7.98	3.14	2	24.4
58-98	43 24 32	107 52 27	7.47	27.60	3.14	3.69	8.79	2.38	2	29.9
58-180	43 24 32	107 52 27	--	40.00	3.80	--	10.53	--	2	54.9
23-432	43 24 30	107 52 29	23.20	23.60	3.24	1.02	7.28	7.16	2	131.7
30-501	43 24 33	107 52 33	10.00	34.00	3.17	3.40	10.73	3.15	2	152.7
30-511	43 24 33	107 52 33	8.65	36.50	2.98	4.22	12.25	2.90	2	155.8
32-466	43 24 32	107 52 31	6.65	24.10	3.55	3.62	6.79	1.87	2	142.0
32-496	43 24 32	107 52 31	14.90	22.70	3.49	1.52	6.50	4.27	2	151.2
41-591	43 24 32	107 52 34	11.00	32.00	3.03	2.91	10.56	3.63	2	180.1
41-596	43 24 32	107 52 34	13.80	19.20	3.92	1.39	4.90	3.52	2	181.7
4-343	43 24 45	107 52 32	16.10	64.10	4.30	3.98	14.91	3.74	2	104.6
BEP-1	42 56 0	109 3 0	3.80	36.60	3.08	9.63	11.88	1.23	2	.0
BEP-2	42 59 0	109 5 0	.90	6.90	4.06	7.67	1.70	.22	2	.0
BEP-3	42 59 0	109 5 0	1.40	16.20	2.53	11.57	6.40	.55	2	.0
BEP-4	42 56 0	109 3 0	5.00	98.20	2.97	19.64	33.06	1.68	2	.0
PRM-1	42 33 20	109 16 0	3.70	64.70	4.16	17.49	15.55	.89	2	.0
PRM-2	42 34 0	109 15 0	.90	25.60	3.63	28.44	7.05	.25	2	.0
PRM-3	42 26 38	109 6 38	6.07	48.80	4.23	8.04	11.54	1.43	2	.0
PRM-4	42 29 52	109 9 32	1.30	30.70	3.26	23.62	9.42	.40	4	.0
PRM-5	42 29 50	109 13 10	1.81	18.50	3.98	10.22	4.65	.45	6	.0
PRM-6	42 29 50	109 13 10	4.54	52.40	4.09	11.54	12.81	1.11	4	.0
PRM-7	42 27 34	108 51 3	1.92	15.10	5.63	7.86	2.68	.34	6	.0
PRM-8	42 26 6	108 55 37	1.18	4.60	2.65	3.90	1.74	.45	6	.0
PRM-9	42 30 8	108 53 17	1.00	7.80	3.44	7.80	2.27	.29	6	.0
PRM-10	42 30 0	108 53 10	1.94	19.40	1.76	10.00	11.02	1.10	4	.0
PRM-11	42 29 39	108 59 19	2.63	15.10	2.19	5.74	6.89	1.20	4	.0
PRM-12	42 31 0	108 58 39	2.23	4.20	2.19	1.88	1.92	1.02	4	.0
PRM-13	42 31 13	109 1 36	2.21	7.91	1.86	3.58	4.25	1.19	4	.0
PRM-14	42 33 45	109 3 46	1.82	12.30	1.28	6.76	9.61	1.42	4	.0
LLB-1	42 32 52	108 45 45	3.10	11.70	3.91	3.77	2.99	.79	6	.0
LLB-2	42 32 31	108 47 52	2.80	15.60	2.27	5.57	6.87	1.23	4	.0

Table 1.- Radioelement contents and ratios for Archean granitic rocks of central Wyoming--continued

Sample	Latitude	Longitude	RaeU ppm	Th ppm	K (wt %)	Th/RaeU	Th/K*	RaeU/K*	Type†	Depth m
LLB-3	42 34 21	108 50 27	2.70	8.80	1.83	3.26	4.81	1.48	4	.0
LLB-4	42 36 19	108 50 49	2.87	14.70	1.86	5.12	7.90	1.54	4	.0
LLB-5	42 43 42	108 50 59	5.72	12.60	1.64	2.20	7.68	3.49	4	.0
LLB-6	42 43 42	108 50 59	6.55	23.50	4.43	3.59	5.30	1.48	2	.0
LLB-7	42 43 42	108 50 59	3.50	21.30	1.76	6.09	12.10	1.99	4	.0
LLB-8	42 41 59	108 55 57	8.38	63.70	3.73	7.60	17.08	2.25	2	.0
LLB-9	42 41 59	108 55 57	3.70	44.90	4.09	12.14	10.98	.90	4	.0
LLB-10	42 41 34	108 53 14	4.59	45.70	3.95	9.96	11.57	1.16	2	.0
LLB-11	42 39 20	108 52 4	5.57	14.10	1.89	2.53	7.46	2.95	4	.0
LLB-12	42 32 52	108 45 45	1.90	15.20	3.11	8.00	4.89	.61	4	.0
LLB-13	42 33 1	108 46 20	8.21	22.00	3.51	2.68	6.27	2.34	2	.0
LLB-14	42 33 45	108 46 57	1.78	11.40	3.06	6.40	3.73	.58	6	.0
LLB-15	42 33 45	108 52 33	3.01	9.77	1.67	3.25	5.85	1.80	4	.0
GPA-1	43 25 35	109 34 34	3.15	28.17	3.36	8.94	8.38	.94	2	.0
GPA-2	43 25 39	109 34 33	4.93	33.47	4.33	6.79	7.73	1.14	2	.0
GPA-3	43 25 42	109 34 36	2.21	41.38	3.85	18.72	10.75	.57	2	.0
GPA-4	43 25 42	109 34 30	6.57	74.04	4.50	11.27	16.45	1.46	2	.0
GPA-5	43 18 54	109 38 29	1.78	10.57	6.27	5.94	1.69	.28	2	.0
GPA-6	43 19 23	109 35 22	2.68	19.04	2.57	7.10	7.41	1.04	2	.0
GPA-7	43 18 25	109 34 27	8.36	78.17	2.36	9.35	33.12	3.54	4	.0
GPA-8	43 20 48	109 38 38	1.70	27.39	2.46	16.11	11.13	.69	4	.0
GPA-9	43 22 35	109 40 55	2.02	78.73	4.60	38.98	17.12	.44	4	.0
GPA-10	43 24 1	109 38 4	7.18	53.67	4.20	7.47	12.78	1.71	2	.0
GPA-11	43 24 26	109 36 37	3.54	47.17	4.42	13.32	10.67	.80	2	.0
GPA-12	43 24 52	109 42 13	1.73	73.21	4.77	42.32	15.35	.36	2	.0
GPA-13	43 1 38	109 31 9	7.72	19.62	1.67	2.54	11.75	4.62	4	.0

*Th/K and RaeU/K have been multiplied by 10^4.

†2 = biotite granite; 4 = mafic granite; 6 = leucocratic granite, and 7 = silicified-epidotized granite.

Note: Samples BBL-1 through TCM-DDH5 are from the Granite Mountains. Samples LG-1 through SD-89H60 are from the Laramie Range. Samples HU-1 through HU-15 are from the Hartville Uplift. Samples 71TDG6 through 4-343 are from the Owl Creek Mountains. Samples BEP-1 through GPA-13 are from the Wind River Range.

GEOLOGIC SETTING

The geologic setting is similar in the five areas studied. In each area the granitic rocks were intruded into a metamorphic sequence of amphibolite facies. The metamorphic sequence is heterogeneous but is dominated by metasedimentary rocks with graywacke as the most common precursor (Peterman and Hildreth, 1978; Condie, 1969; Snyder, 1980; Tourtelot, 1953; Thaden, 1976 a,b,c; Pearson and others, 1971; Granger and others, 1971). Few radiometric ages are available for the time of metamorphism, but ages of approximately 2,900 m.y. have been reported for the metamorphic rocks in the Granite Mountains (Nkomo and Rosholt, 1972; Peterman and Hildreth, 1978). Somewhat younger ages have been obtained for metamorphic rocks from the Owl Creek Mountains (C. E. Hedge, oral communication, 1980), from the Wind River Range (Bassett and Giletti, 1963), and from the Laramie Range (Johnson and Hills, 1976), although the latter area also yielded a tentative age of 2,960 ± 220 m.y. for a sillimanite - bearing gneiss[1].

In the Granite Mountains and the Wind River Range, granitic rocks were emplaced during at least two postmetamorphic, intrusive episodes (Ludwig and Stuckless, 1978; Naylor and others, 1970). The northern Laramie Range may also be formed by more than one Archean granite (Wenner and others, 1981).

All of the intrusive ages for areas sampled for this study are late Archean except for those of the Hartville uplift where some middle Proterozoic granite is reported (Snyder, 1980). In the Granite Mountains, the volumetrically minor granite of Long Creek Mountain has been dated by the U-Pb zircon method at 2,640 ± 20 m.y. (Ludwig and Stuckless, 1978). An estimated 85 percent of the Granite Mountains is made up of the biotitic phase (biotite

[1] Where necessary, ages cited in this paper have been recalculated using the decay constants recommended by the IUGS Subcommission on Geochronology (Steiger, and Jager, 1977).

2 to 15 percent by volume) of the granite of Lankin Dome. Another 10 percent is made up of the leucocratic phase of this unit. The granite of Lankin Dome has been dated by the U-Pb zircon method at 2,595 ± 40 m.y. (Ludwig and Stuckless, 1978), and the biotitic phase has been identified as the major contributor of uranium (in terms of g U loss per gram of rock) to the surrounding area (Stuckless and Nkomo, 1978).

At least two major granitic units crop out in the Wind River Range: the Louis Lake batholith of Bayley (1965 a,b) which is a quartz diorite to granodiorite, and the Popo Agie batholith of Pearson and others (1971) which is a granite and quartz monzonite. The Louis Lake batholith has been dated by the U-Pb zircon method at 2,642 ± 9 m.y. (Naylor and others, 1970). The Bears Ears pluton of Naylor and others (1970) has been dated by the U-Pb zircon methods at 2,562 ± 75 m.y. This unit appears to be part of the Popo Agie batholith.

Only one intrusive event has been noted in the Owl Creek Mountains. Nkomo and others (1978) report a preliminary Pb-Pb whole-rock age of 2,645 ± 60 m.y. However, the geology is complex, and the existence of two intrusive events is not precluded.

Geochronologic studies in the Hartville uplift are in progress at this time. Preliminary Rb-Sr whole-rock results suggest an age of approximately 2,600 m.y. (Z. E. Peterman, oral communication, 1980).

Three separate whole-rock ages have been reported for the granite in the northern Laramie Range. The Rb-Sr results are 2,496 ± 40 m.y. (Hills and Armstrong, 1974) and 2,512 ± 25 m.y. (Johnson and Hills, 1976). The reported Pb-Pb age is 2,530 ± 80 (Nkomo and others, 1979).

The Archean granites of central Wyoming have been affected by multiple postintrusive events. Each area has been intruded by diabase dikes. At least some of these are only slightly younger than the granites (Peterman and Hildreth, 1978), but two younger periods of dike intrusion may exist (Condie and others, 1969).

The southern portion of the area studied was affected by at least one middle Proterozoic event that reset K-Ar and Rb-Sr mineral ages (Peterman and Hildreth, 1978). The resetting is interpreted to be the result of vertical tectonics. The Owl Creek Mountains and northern Wind River Range are not known to have been affected by this event; however, in these areas much of the exposed granite is close to the Cambrian weathering surface (Granger and others, 1971; Nkomo and others, 1978). All of the areas studied were uplifted and eroded during the Laramide event.

Table 2.--Statistical measurements of radioelement contents and ratios in samples of Archean granite from central Wyoming

				Arithmetic treatment				Logarithmic Treatment				
	N	Minimum	Maximum	Mean	σ	Skewness	Kurtosis	Mean	+σ	-σ	Skewness	Kurtosis
RaeU (ppm)	474	0.30	75.3	4.50	6.56	7.11	66.69	3.00	3.8	- 1.69	0.43	0.81
Th (ppm)	476	2.20	159	38.23	24.26	1.18	2.26	30.48	32.99	-15.84	-0.75	0.58
K (wt.%)	468	0.0	7.46	3.68	1.22	-1.31	1.90	3.12	4.25	- 1.80	-4.26	23.55
Th/RaeU	474	0.31	122	14.01	12.68	3.05	15.69	10.13	13.64	- 5.81	-0.55	1.24
Th/K*	467	0.29	1866	28.79	118.9	10.08	131.6	9.62	17.54	- 6.21	1.50	5.70
RaeU/k*	467	0.04	233	5.10	21.94	7.18	58.04	0.94	2.39	- 0.68	1.86	4.80
Normal						±0.19	±0.39 -0.43					

*Th/K and RaeU/K have been multiplied by 10^4

Table 3.--Statistical measurements of radioelement contents and ratios in samples of Archean granite from central Wyoming, grouped by area

				Arithmetic treatment				Logarithmic Treatment				
	N	Minimum	Maximum	Mean	σ	Skewness	Kurtosis	Mean	+σ	-σ	Skewness	Kurtosis
Granite Mountains												
RaeU (ppm)	337	0.41	68.3	3.82	4.99	7.52	85.33	2.68	3.19	- 2.68	0.39	0.78
Th (ppm)	338	3.20	159.0	40.32	23.99	1.10	2.17	32.96	32.85	-16.34	-0.79	0.64
K (wt.%)	338	0.0	5.94	3.73	1.22	-1.70	2.44	3.09	4.85	- 1.88	-4.17	21.63
Th/RaeU	337	0.31	122.0	16.20	13.67	2.97	14.23	12.26	14.50	- 6.66	-0.59	1.97
Th/K*	338	0.66	1866.7	34.06	136.9	8.97	102.1	10.37	20.03	- 6.83	1.69	5.53
RaeU/K*	337	0.10	223.4	5.61	24.61	6.62	48.35	0.85	2.28	- 0.62	2.15	5.58
Normal						± .223	+ .49 - .39					
Laramie Range												
RaeU (ppm)	45	1.15	21.7	4.79	4.25	2.38	6.74	3.62	3.85	- 1.87	0.50	-0.38
Th (ppm)	45	8.57	144.5	38.11	30.55	1.60	2.60	29.03	31.66	-15.14	0.29	-0.80
K (wt.%)	37	0.27	5.19	3.51	1.12	-1.68	2.92	3.10	2.89	- 1.50	-2.95	8.29
Th/RaeU	45	1.97	41.41	10.05	7.70	2.26	6.43	8.01	7.79	- 3.95	0.05	0.05
Th/K*	37	2.06	437.9	23.79	71.18	5.78	34.33	9.64	17.10	- 6.17	1.56	4.42
RaeU/K*	37	0.32	65.76	3.92	11.98	4.59	21.75	1.16	2.43	- 0.78	2.11	5.41
Normal						±.55	---					
Hartville Uplift												
RaeU (ppm)	12	1.00	12.0	5.66	3.73	0.67	- 0.84	4.49	5.05	- 2.38	-0.45	-0.26
Th (ppm)	12	7.70	68.6	40.92	16.07	-0.42	0.55	36.64	28.03	-15.88	-2.04	5.27
K (wt.%)	12	3.81	5.90	4.68	0.66	0.58	- 0.35	4.64	0.68	0.60	0.34	-0.68
Th/RaeU	12	2.77	17.78	9.36	4.50	0.09	- 0.33	8.16	6.58	- 3.64	-0.85	-0.31
Th/K*	12	1.59	14.14	8.97	3.72	-0.56	- 0.19	7.90	6.38	- 3.53	-1.86	4.00
RaeU/K*	12	0.21	2.96	1.26	0.88	0.73	- 0.39	0.97	1.23	- 0.54	-0.49	-0.56

*Th/K and RaeU/K have been multiplied by 10^4.

Table 3.--Statistical measurements of radioelement contents and ratios in samples of Archean granite from central Wyoming, grouped by area.--continued

				Arithmetic treatment				Logarithmic treatment				
	N	Minimum	Maximum	Mean	σ	Skewness	Kurtosis	Mean	+σ	-σ	Skewness	Kurtosis
Owl Creek Mountains												
RaeU (ppm)	34	0.30	75.3	11.79	16.34	3.22	10.65	6.41	14.44	- 4.44	-0.44	0.90
Th (ppm)	35	2.20	64.1	27.49	15.15	0.06	- 0.21	21.14	30.29	-12.45	-1.40	1.05
K (wt.%)	35	0.14	7.46	3.61	1.35	- .005	3.04	3.07	3.83	- 1.70	-3.35	11.59
Th/RaeU	34	0.34	20.96	4.78	4.81	2.19	4.66	3.24	4.90	- 1.95	-0.27	0.73
Th/K*	35	0.29	274.3	15.55	45.23	5.83	34.29	6.90	13.38	- 4.55	0.08	5.02
RaeU/K*	34	0.04	117.9	6.93	20.35	5.24	25.35	2.10	6.19	- 1.57	0.25	2.87
Wind River Range												
RaeU (ppm)	46	.90	8.38	3.52	2.17	0.92	-0.22	2.94	2.53	- 1.36	0.01	-0.82
Th (ppm)	46	4.20	98.2	30.54	23.77	1.12	0.37	22.68	27.78	-12.48	-0.03	-0.76
K (wt.%)	46	1.28	6.27	3.24	1.17	0.27	-0.45	3.02	1.43	- 0.97	-0.36	-0.87
Th/RaeU*	46	1.88	42.32	10.14	8.70	2.23	5.47	7.72	8.31	- 4.01	0.23	-0.07
RaeU/K*	46	1.69	33.12	9.44	6.67	1.93	5.28	7.50	7.90	- 3.84	-0.42	0.04
Normal	46	0.22	4.62	1.25	0.94	1.71 $\pm$0.55	3.44	0.97	1.05	- 0.50	-0.12	-0.45

*Th/K and RaeU/K have been multiplied by 10^4.

Table 4.--Statistical measurements of radioelement contents and ratios for Data grouped by rock type

				Arithmetic treatment				Logarithmic Treatment				
	N	Minimum	Maximum	Mean	σ	Skewness	Kurtosis	Mean	+σ	-σ	Skewness	Kurtosis
Biotite granite												
RaeU (ppm)	329	0.53	75.3	4.68	6.43	7.54	74.84	3.32	3.76	- 1.76	0.56	1.05
Th (ppm)	330	3.20	133.0	43.81	21.22	0.93	1.31	38.63	27.20	-15.96	-0.82	1.86
K (wt.%)	322	1.63	6.34	4.09	0.67	-0.37	1.54	4.03	0.78	- 0.66	-1.27	3.31
Th/RaeU	329	0.31	122.0	15.66	13.31	3.03	15.67	11.64	14.95	- 6.54	-0.81	2.40
Th/K*	322	1.67	33.06	10.73	4.84	1.21	2.86	9.68	5.85	- 3.65	-0.66	1.61
RaeU/K*	321	0.13	26.89	1.21	2.07	9.05	100.2	0.82	0.94	- 0.44	.83	1.91
normal						± .223	+ .485 - .385					
Leucocratic granites												
RaeU (ppm)	58	0.30	4.52	1.79	1.03	0.85	0.23	1.50	1.33	- 0.70	-0.49	-0.15
Th (ppm)	58	2.20	52.0	13.25	7.51	2.42	11.26	11.52	8.45	- 4.87	-0.46	1.01
K (wt.%)	58	2.65	7.46	4.22	0.74	1.46	5.51	4.16	0.75	- 0.64	0.39	2.30
Th/RaeU	58	1.21	50.70	9.77	8.03	2.85	11.28	7.70	7.61	- 3.38	0.02	0.76
Th/K	58	0.29	11.71	3.21	1.75	2.03	8.61	2.77	2.21	- 1.23	-1.07	3.15
RaeU/K*	58	0.04	1.28	0.44	0.27	1.06	0.92	0.36	0.36	- 0.18	-0.66	0.76
normal						± 0.55						
Mafic granites												
RaeU (ppm)	49	0.48	68.30	3.85	9.57	6.62	45.35	2.14	2.84	- 1.22	1.38	4.66
Th (ppm)	49	2.56	112.0	26.48	24.94	1.90	3.19	18.58	24.93	-10.64	0.06	-0.03
K (wt.%)	49	1.28	4.94	2.71	0.89	0.64	-0.35	2.58	0.98	- 0.71	0.07	-0.74
Th/RaeU	49	0.96	76.67	13.14	14.07	2.65	8.58	8.67	13.26	- 5.52	-0.03	0.10
Th/K*	49	0.74	45.53	10.02	9.16	2.37	6.42	7.20	9.56	- 4.11	-0.26	0.44
RaeU/K*	49	0.12	16.42	1.40	2.40	5.40	33.30	0.83	1.24	- 0.35	0.72	1.08
normal						± 0.55						

*Th/K and RaeU/K have been multiplied by 10^4.

Table 4.--Statistical measurements of radioelement contents and ratios for Data grouped by rock type (continued)

				Arithmetic treatment				Logarithmic treatment				
	N	Minimum	Maximum	Mean	σ	Skewness	Kurtosis	Mean	+σ	-σ	Skewness	Kurtosis
Hydrothermally altered granites												
RaeU (ppm)	38	0.5	26.7	7.87	6.31	1.36	1.70	5.63	8.10	- 3.31	-0.43	-0.01
Th (ppm)	39	2.84	159	42.96	34.08	1.93	4.16	32.52	39.91	-17.92	-0.61	1.41
K (wt.%)	39	0.0	2.84	0.72	0.87	1.48	0.96	0.31	1.16	- 0.24	-1.08	3.28
Th/RaeU*	38	0.79	22.4	7.71	5.87	1.08	0.55	5.64	7.67	- 3.25	-0.40	-0.46
Th/K	38	5.93	1866.	254.1	354.1	2.87	11.14	88.80	350.0	-70.83	-0.09	-1.12
RaeU/K*	38	0.65	223.3	49.02	61.88	1.58	1.89	15.75	82.96	-13.24	-0.36	-1.08
All unaltered granites												
RaeU (ppm)	436	0.30	75.3	4.21	6.51	7.83	76.14	2.84	2.35	- 1.57	0.48	1.22
Th(ppm)	437	2.22	133.0	37.81	23.19	0.90	0.87	30.31	32.45	-15.67	-0.77	0.51
K (wt.%)	429	1.28	7.46	3.95	0.83	-0.52	1.40	3.85	1.07	- 0.84	-1.50	2.96
Th/RaeU*	436	0.29	122.0	14.56	12.96	3.00	15.04	10.57	14.16	- 6.06	-0.68	1.90
Th/K	429	0.29	45.52	9.63	5.83	1.66	6.05	7.90	7.55	- 3.86	-0.96	1.65
RaeU/K*	429	0.04	35.79	1.21	2.59	9.46	105.7	0.74	0.98	- 0.42	0.71	2.35
normal						±0.195	+0.415 -0.340					

*Th/K and RaeU/K have been multiplied by 10^4.

RESULTS AND DISCUSSION

The data for radioelement contents and ratios are presented in table 1. The entire data set was evaluated statistically using both arithmetic and logarithmic input (table 2). Subsets of the data grouped by area (table 3) and by rock type (table 4) were treated in a similar fashion.

In the total data set, and for each subset where there are enough data for a statistically valid estimate, the uranium and thorium data and ratios involving these elements more closely approximate a lognormal distribution than a normal one. This tendency is indicated by the lower absolute values of skewness and kurtosis calculated in the logarithmic treatment relative to those of the arithmetic treatment (tables 2, 3, and 4). The approximation of lognormal distributions is also shown graphically for all of the thorium data and for all of the Th/RaeU ratios on figures 2 and 3. Potassium data are better represented by a normal distribution; this is especially true if hydrothermally altered samples are omitted from the statistical treatment (table 4). Subsequent discussion of the results will therefore use the arithmetic mean and deviation for potassium and the geometric means and deviations for uranium and thorium and for ratios involving these two elements.

In order to evaluate anomalies, we have compiled data for approximately 2,000 granitic samples (including those given in this report) for the contiguous United States. The arithmetic averages for uranium and thorium concentrations are not significantly different from those given by Rogers and Adams (1969 a,b), but our data base allows us to use geometric means and means of ratios rather than ratios of means. For our preliminary U.S. data base, geometric means for uranium, thorium, Th/U, Th/K, and U/K are 3.54 ppm, 16.76 ppm, 4.73, 5.00 X 10^{-4}, and 1.05 X 10^{-4} respectively. The arithmetic mean for potassium (as K) is 3.59 weight percent.

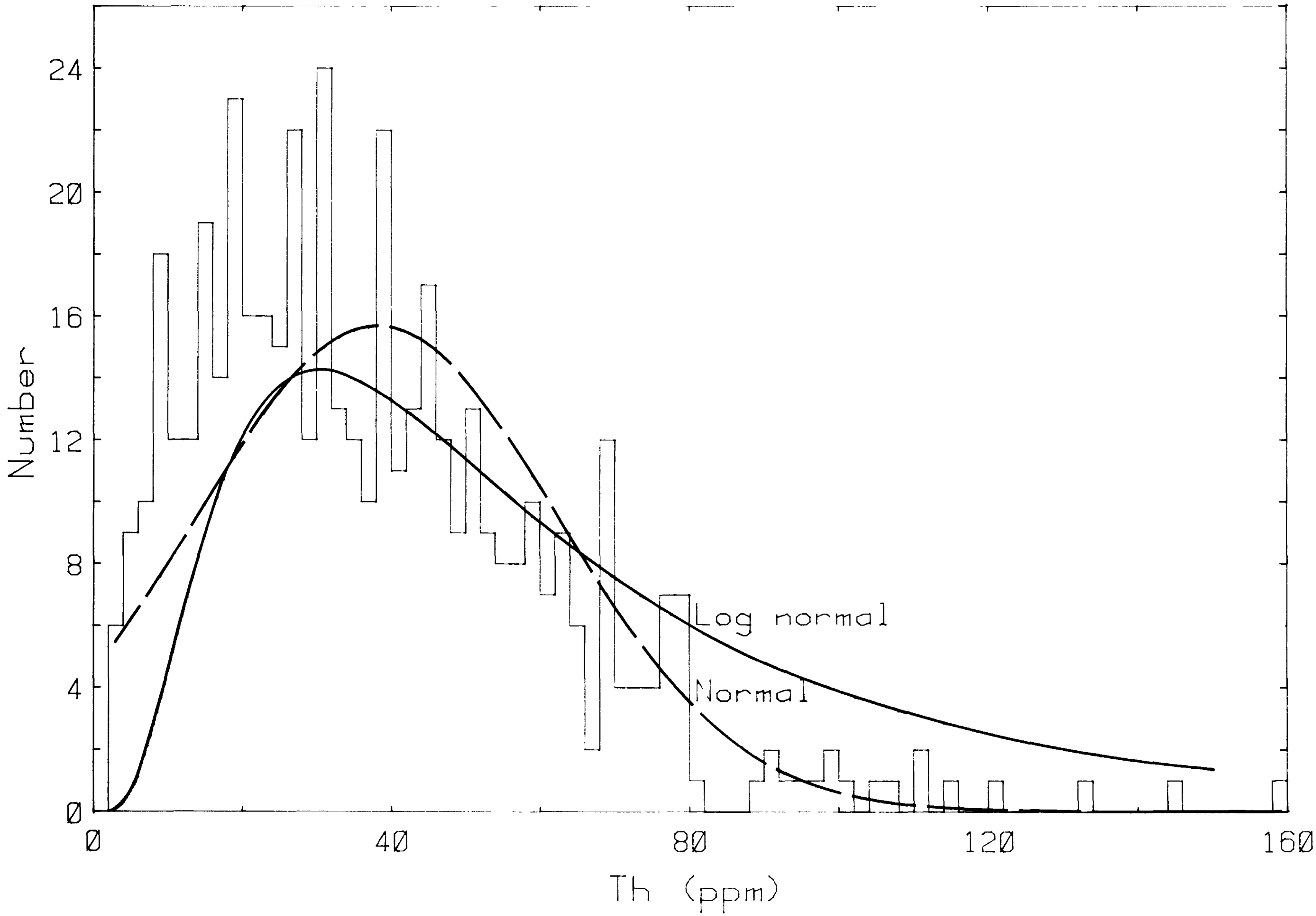


Figure 2.--Histogram showing thorium distribution for all granite samples from the Archean of central Wyoming. The dashed curve represents a normal distribution. The solid curve represents a lognormal distribution. Both curves are calculated on the basis of the actual data.

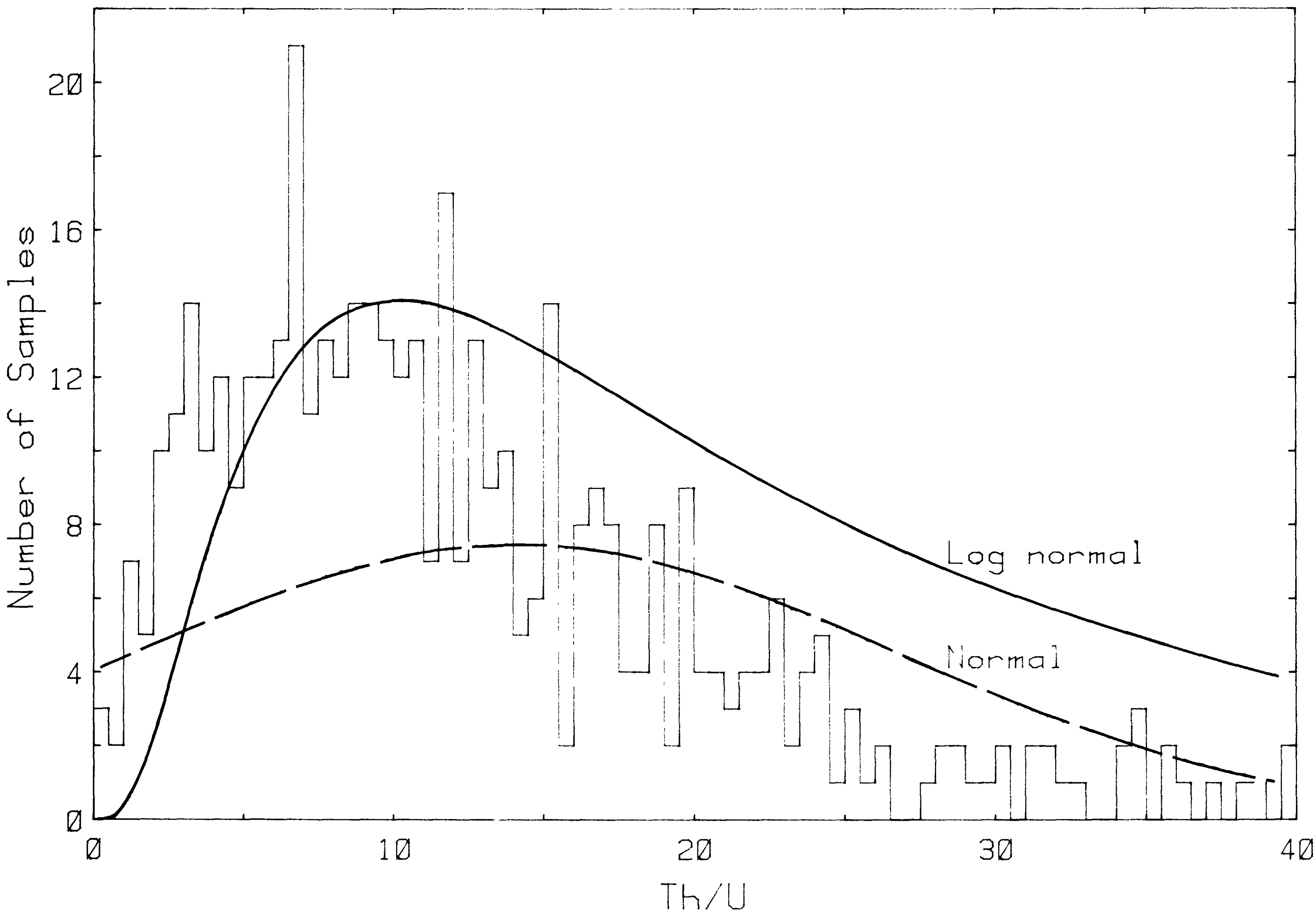


Figure 3.--Histogram showing the distribution of Th/RaeU ratios for all granitic samples from the Archean of central Wyoming. The dashed curve represents a normal distribution and the solid curve represents a lognormal distribution. Both curves are calculated on the basis of the actual data.

Subdividing the central Wyoming data on the basis of rock type (table 4) shows clear differences in radioelement contents and small differences in radioelement ratios. Relative to our U.S. data base, the biotite granites contain approximately normal amounts of uranium, but are greatly enriched in thorium. Consequently Th/U and Th/K ratios are anomalously high. The leucocratic granites have anomalously low uranium and thorium contents, but still exhibit a high Th/U ratio. The mafic granites contain approximately normal amounts of thorium and have slightly low uranium contents. Both Th/U and Th/K ratios are somewhat high. The U/K ratio for each type of unaltered granite is somewhat low relative to our U.S. data base.

The hydrothermally altered granites are markedly depleted in potassium and slightly high in uranium content, and they contain nearly twice as much thorium as the average U.S. granite. The resulting ratios are nearly normal for Th/U and anomalously high for Th/K and U/K. However, exclusion of these obviously atypical samples from the total data set does not markedly change the means or statistical parameters for uranium, thorium, or the Th/U ratio (tables 2 and 4). Thus, in order to retain as large a data base as possible for comparisons between areas, all samples will be used.

The relative proportions of uranium, thorium, and potassium for each of the sampled areas is compared to our U.S. data base on figure 4 by use of lines that represent geometric means for radioelement ratios in the U.S. data base. For each of the five areas, most of the data plots to the left of the line that indicates a Th/K ratio of 5.0×10^{-4}. Thus all five areas exhibit high thorium contents relative to potassium.

Uranium concentrations relative to potassium are not generally anomalous (fig. 4). In the Owl Creek Mountains there is a tendency towards high uranium contents relative to potassium, but these data are dominated by drill core

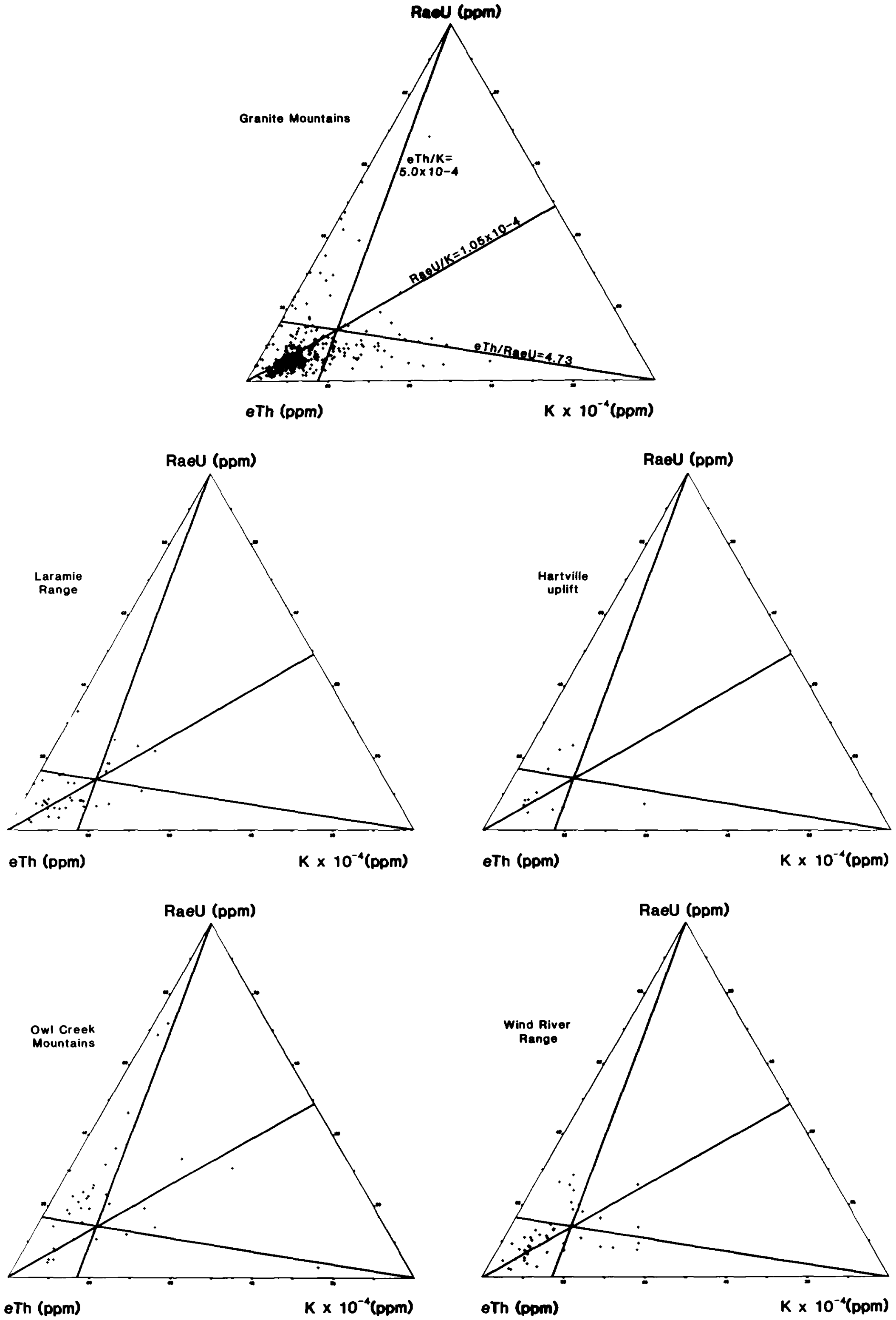


Figure 4.--Ternary diagrams showing relative proportions of uranium (RaeU), thorium (eTh), and potassium (K X 10^{-4}) for each of the sampled areas. Lines representing geometric means for radioelement ratios in a data set of approximately 2000 granitic rocks are shown for comparison.

samples (supplied by Rocky Mountain Energy) and therefore may not be representative of granite at the surface. Furthermore, the area drilled is mineralized, although obviously mineralized samples were excluded from the data sets. In the Granite Mountains and to a lesser extent in the Laramie Range, there is a tendency towards low concentration of uranium relative to potassium, but the geometric means are not significantly different from the 1.05×10^{-4} mean of our U.S. data base.

In each area, except the Owl Creek Mountains, most of the data plot below a line corresponding to a Th/U ratio of 4.73 (fig. 4). Thus, thorium contents are generally high relative to uranium. In the Owl Creek Mountains, high thorium relative to uranium occurs only in some of the surface samples (Table 1).

Inasmuch as thorium contents are high relative to both uranium and potassium, the high Th/U ratios in four of the five areas might be attributed to thorium enrichment, however isotopic data suggest that the high ratios are due to Tertiary uranium depletion. This is shown on figure 5, where Th/U ratios calculated from thorogenic and uranogenic lead are compared to measured ratios. Implicit in the construction of this diagram is that the age of the granite and initial composition of lead are known and that lead has not been gained or lost. For most of the samples, these conditions can be satisfied. To change the geometric mean Th/U ratio from 1.86 to 3.93 for the samples shown on figure 5 requires an average uranium loss of 60 percent. If the isotopic data are typical of the entire sample population, then the Th/RaeU ratio of 10.13 (table 2) indicates an average uranium loss of approximately 82 percent.

Although the Archean granitic rocks of central Wyoming are all enriched in thorium relative to a preliminary average for granitic rocks of the United

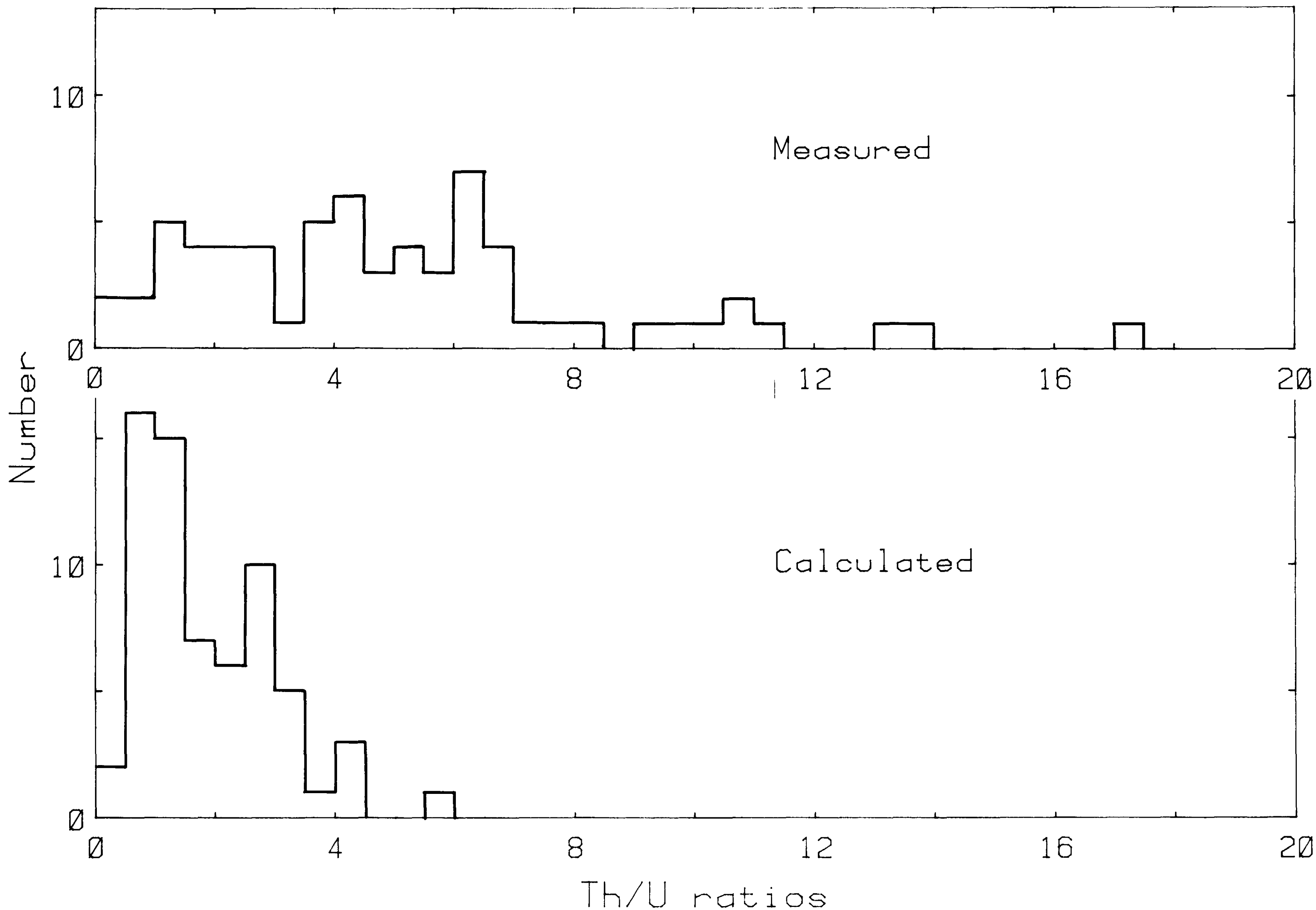


Figure 5.--Histograms showing Th/U ratios calculated from lead isotopic data and as actually measured. Data from Rosholt and Bartel (1969), Rosholt and others (1973), Stuckless and Nkomo (1978), and Nkomo and others (1978, 1979).

States, and all seem to have been enriched in uranium at one time, the Eocene paleodrainage reconstruction of Seeland (1976, 1978, and written communication, 1981) shows that all but two of the Wyoming Tertiary uranium deposits are in sandstones whose provenance was the Granite Mountains or the Northern Laramie Range. We tentatively suggest that although all five areas contain granites that are similar in radioelement distribution, geologic differences may explain the distribution of uranium ore.

Much of the granite in the Owl Creek Mountains, the Hartville uplift, and at least the northern part of the Wind River Range has not been deeply eroded during the Tertiary. Thus much of the currently exposed weathering surface was also exposed during the late Precambrian, and it is possible that the granite in these areas lost leachable uranium at that time. As a result, these granites would not have been able to provide much uranium to nearby Tertiary basins.

The dominant type of granite within a given area is another variable that may be highly significant in the determination of source-area favorability. Leucocratic and mafic granites currently contain much less thorium and uranium than biotite granite (table 4), and thus terrane dominated by these rock types may provide a much less favorable source. Much of the southern Wind River Range is dominated by the Louis Lake batholith, which is a mafic granitic rock (quartz diorite to granodiorite). Thus the apparent lack of uranium deposits in sediment with this provenance seems reasonable.

Silver (1976) suggested that uranium content of zircons might be an indicator of uranium provinces. By analogy, zircons with more than 1000 ppm uranium may be an indicator of source-rock favorability. Zircons from the Louis Lake Batholith contain less than 500 ppm uranium (Naylor and others, 1970). In contrast, zircon from the spatially associated Bears Ears pluton contains more than 1500 ppm uranium (Naylor and others, 1970). Thus two independent lines of evidence suggest that the southern Wind River Range may contain both favorable and unfavorable source rock.

Zircon data are also avilable for the Granite Mountains (Ludwig and Stuckless, 1978). Two samples of the biotite granite of Lankin Dome and one of the hydrothermally altered equivalent contain zircons with uranium concentrations in excess of 1500 ppm. The earlier granite of Long Creek Mountain is a low thorium granite with relatively low Th/U ratios. Zircons from one sample of this unit contain an average of 850 ppm uranium (Ludwig and Stuckless, 1978).

In view of the correspondence of high Th/U ratios with large amounts of uranium loss and the correspondence of uraniferous zircons with high whole-rock thorium contents, these radioelement characteristics are considered to be significant indicators of uranium provinces similar to that in central Wyoming. The distribution of high thorium contents and high Th/U ratios relative to the Eocene paleodrainage and known ore deposits is shown on figures 6 and 7. Although the high sample density in the Granite Mountains relative to that in the other four areas tends to overemphasize this area, the proportion of samples with more than twice the geometric mean of our U.S. data base is by far greatest in the Granite Mountains for both thorium contents and Th/U ratios. The lowest proportion of anomalous samples is in the southern Wind River Range. Approximately one third of the samples from the northern Laramie Range are anomalous in terms of both thorium contents and Th/U ratios. This area and the Granite Mountains (which were deeply eroded in the Tertiary) are the provenance for the sandstones that host uranium ore.

Figure 6.- Map of the central Wyoming region showing distribution of samples with anomalous thorium contents (small open squares), the distribution of Tertiary uranium deposits (Butler 1972), and the Eocene drainage pattern (Seeland, 1976, 1978, and written communication, 1981). Small squares indicate thorium contents greater than 39 ppm; pluses indicate thorium contents between 39 and 16.5 ppm; dots indicate thorium contents less than 16.5 ppm. Data are gridded to a 2-minute grid and plotted points represent averages of all data within a 2-minute area. The large solid squares represent uranium districts with more than 1,000,000 tons of ore. Solid circles represent deposits with 1,000 to 1,000,000 tons of ore, and open circles represent deposits with less than 1,000 tons of ore.

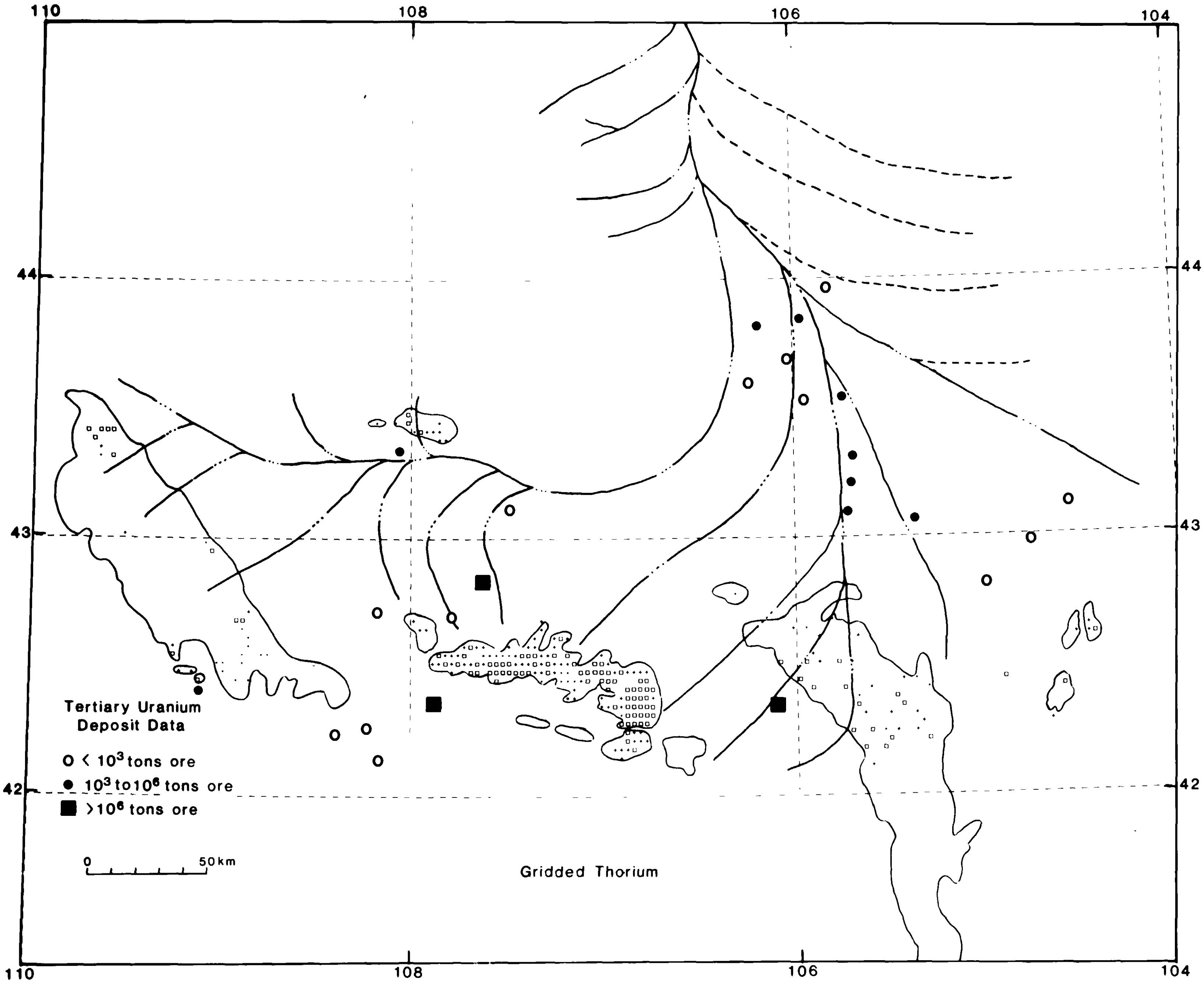
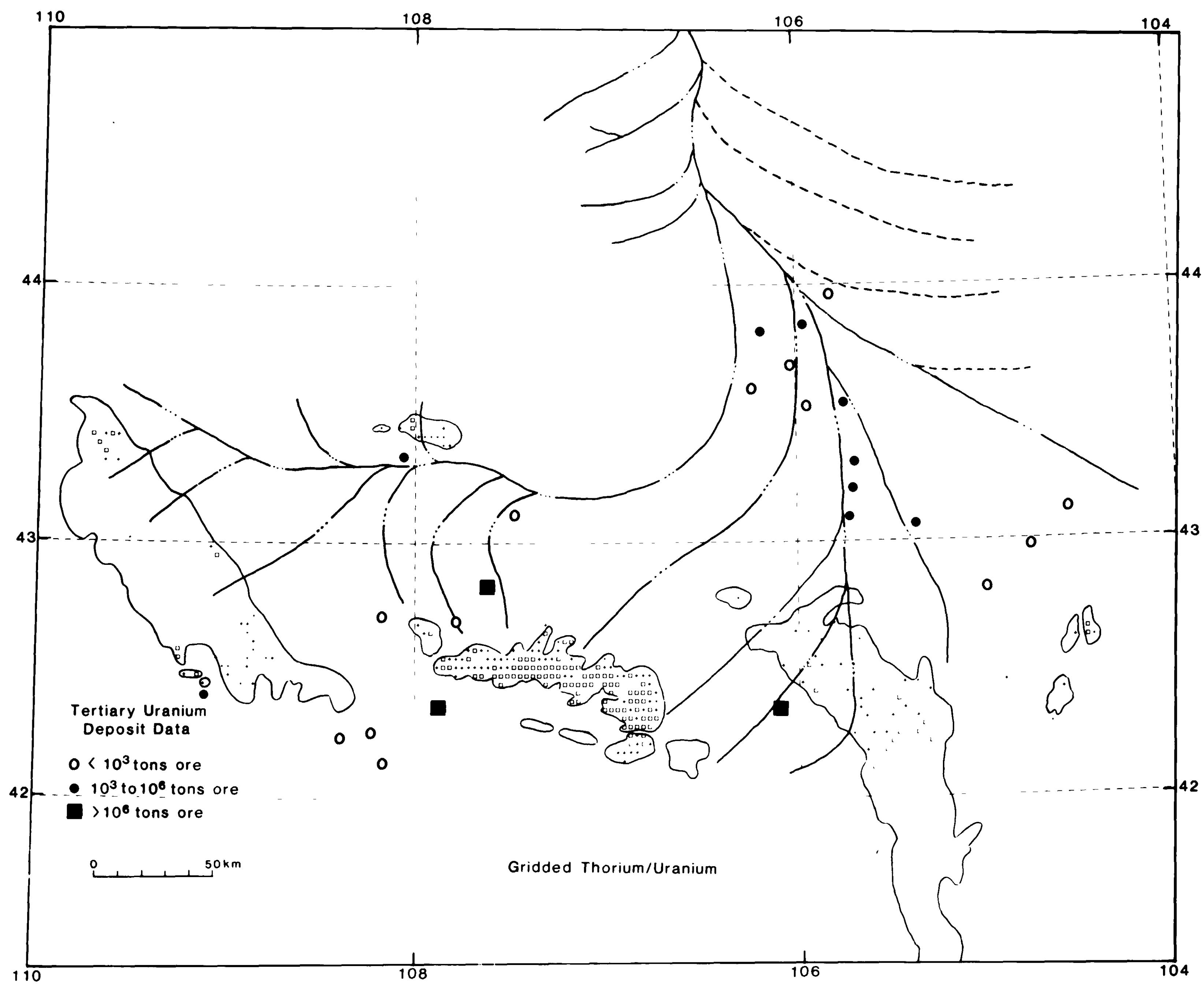

110
108
106
104
44
43
42
Tertiary Uranium
Deposit Data
O < 10³ tons ore
● 10³ to 10⁶ tons ore
■ >10⁶ tons ore
0
50km
Gridded Thorium

Figure 7.- Map of the central Wyoming region showing distribution of samples with anomalous Th/U ratios (small open squares), the distribution of Tertiary uranium deposits (Butler, 1972) and the Eocene drainage pattern (Seeland, 1976, 1978, and written communication, 1981). Small squares indicate Th/U ratios greater than 11.8; pluses indicate a Th/U ratio between 5.1 and 11.8; dots indicate a Th/U ratio less than 5.1. Data are gridded to a 2-minute grid, and plotted points represent averages of all data within a 2-minute area. See added description on Fig. 6.


110
108
106
104
44
43
42
Tertiary Uranium
Deposit Data
O < 10³ tons ore
● 10³ to 10⁶ tons ore
■ > 10⁶ tons ore
0
50km
Gridded Thorium/Uranium

SUMMARY

The Archean granites of central Wyoming are characterized by anomalously high thorium contents and high Th/U ratios. This is especially true of granites in the provenance region for the Tertiary sandstones that host uranium ore. In the areas for which the high Th/U ratios can be assessed, isotopic data indicate that Tertiary uranium loss caused the ratios to change from anomalously low (<2) to anomalously high (10).

The Hartville uplift, Owl Creek Mountains, and northern Wind River Range are associated closely, with only small uranium deposits. Granites in the latter two areas tend to be less anomalous in terms of thorium content and Th/U ratios (Table 3). Furthermore, much of the granite in all three regions is close to the Cambrian weathering surface and may have lost most of its leachable uranium prior to the deposition of the mineralized Tertiary sandstones.

The southern Wind River Range is more deeply eroded; however, much of the granitic rock in this region is fairly mafic. This type of granite does not seem to be particularly anomalous in terms of thorium content or Th/U ratio. Thus the apparent lack of large uranium deposits in sandstones with this provenance is not surprising.

Finally, the statistical distribution of uranium and thorium concentrations and ratios involving these elements is approximated more closely by a lognormal distribution than by a normal one. Work is in progress to see if log-normal distribution is typical for these variables for granitic rocks in general.

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