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Field Test of the Geometrics Exploration Model GR-410 Portable Gamma Ray Spectrometer with a Model GPX-21 Detector, Marion County, Alabama

Walter O'Niell

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The Mississippi Mineral Resources Institute
University, Mississippi 38677

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By

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INTRODUCTION:

A Geometries Exploranium Model GR-410 Portable Gamma Ray Spectrometer with a model GPX-21 detector was tested in the Black Warrior Basin, Marion County, Alabama, to see if it is sensitive enough for practical detection of radon leakage from oil and gas reservoirs. Sand, gravel, and clay of the Cretaceous Tuscaloosa Group are exposed at the surface in this area. Beneath the Tuscaloosa sediments are approximately 2500 feet of sandstone, shale, and coal of the Pennsylvanian Pottsville Formation overlying limestone, shale, and sandstone of Mississippian Age. Several gas wells have been completed in the area at depths of approximately 1000 to 1200 feet in Mississippian sand bodies (Lewis, Evans, and Abernathy) (Figure 1). Well sites were in part selected on the basis of LANDSAT imagery lineaments interpreted as faults or fractures.

The test was intended to determine if radon leakage or radionuclides in the oxidized zones of faults or fractures could be detected with the gamma ray spectrometer. Two types of tests were performed. First the spectrometer was used to continuously scan the area in a slow-moving vehicle (10-15 miles per hour) along five lines (A-B-C-D-E-F-G-H-I, B-F, C-I, D-J, and G-K, Figure 2). The levels of the total count of potassium, uranium, and thorium were monitored on the analog scale of the spectrometer and recorded in Appendix A.

The second test was of the individual potassium, uranium, and thorium levels - as well as the total count of the three - at 18 stations (Figure 2). The radiation levels, measured for specific time intervals, were recorded from the digital display of the spectrometer. Percentages of the total count of potassium, uranium, and thorium radiation were then calculated (Appendix B).

The locations of both tests were chosen along lineaments, along and within circular anomalies mapped from LANDSAT data, at lineament intersections, at actual or proposed well sites, and in areas near neither circular anomalies nor lineaments.

COMPOSITE WARRIOR BASIN ELECTRIC LOG

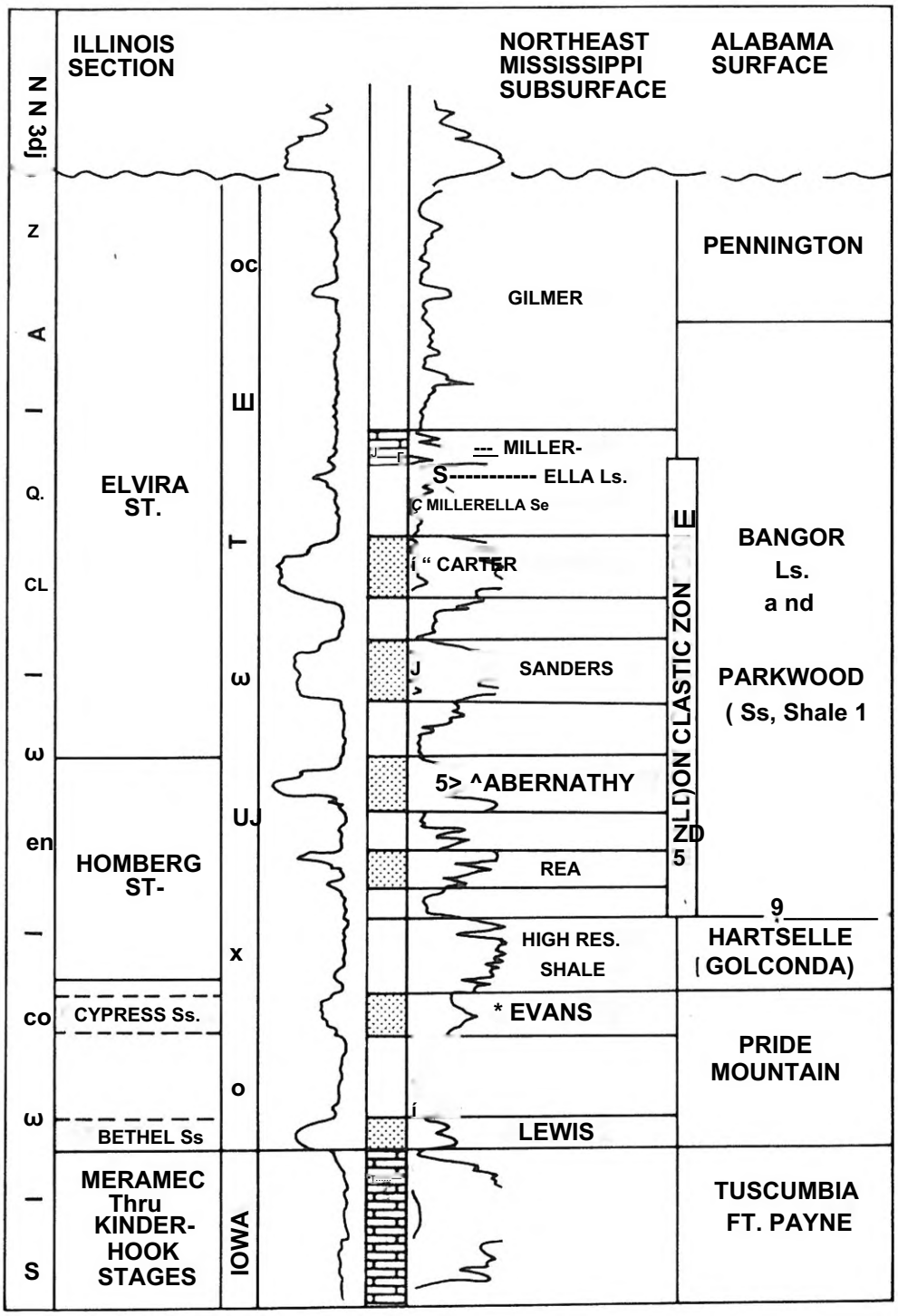

Figure 1. Composite Electric Log of Mississippian Strata, Black Warrior Basin.

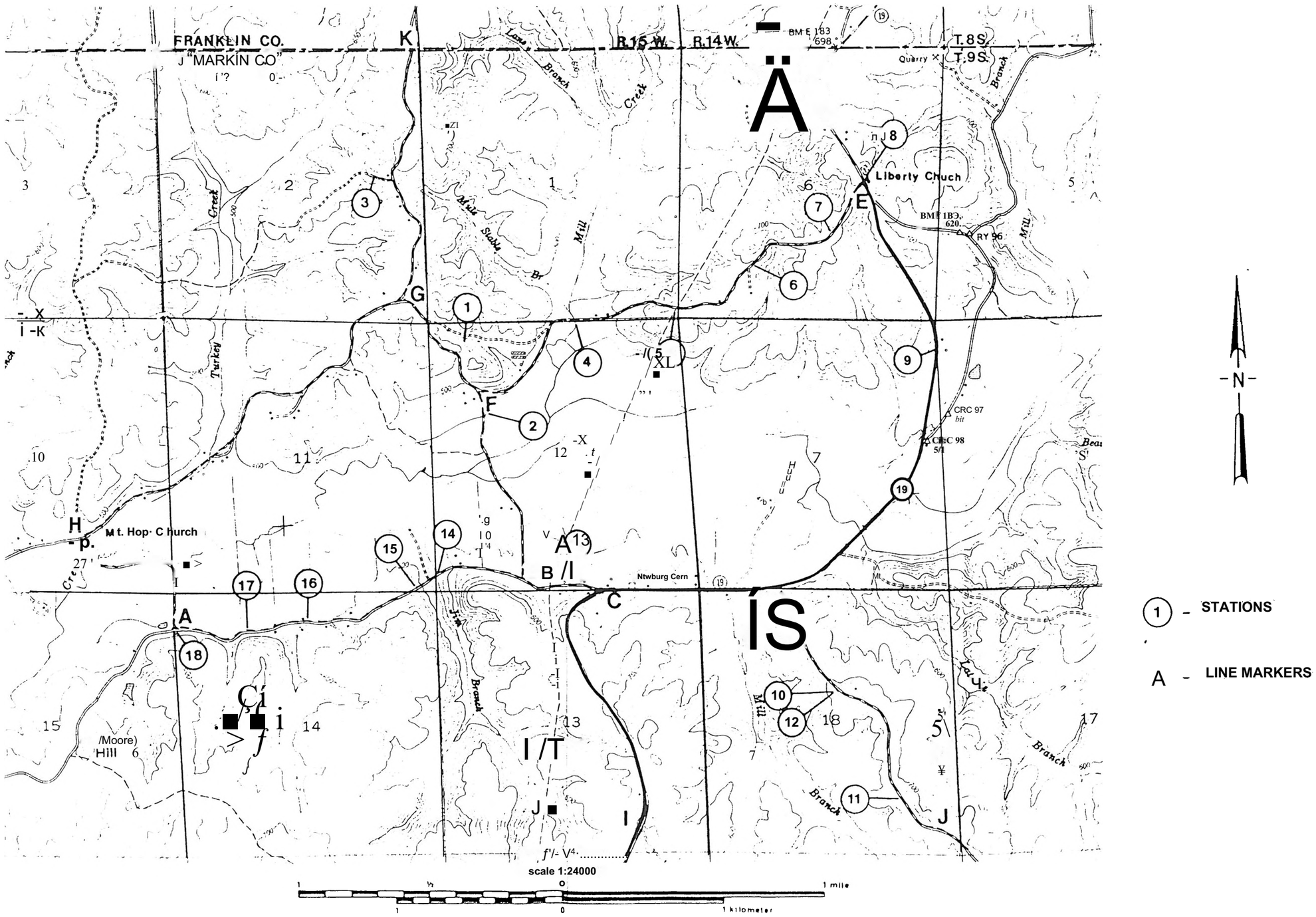

Figure 2. Location of the Study Area.

RESULTS OF THE TESTS:

No significant changes in count rates were noted. The levels of the total count and individual count rates did not notably deviate from the background level. While variation was noticeable, no correlation could be recognized between areas with a "normal" background level and those with subtle changes from it.

CONCLUSIONS:

Several conclusions may be drawn concerning the results:

1. The spectrometer was not sensitive enough to detect radon gas or radionuclides associated with regional fractures, if such radioactivity is present.
2. No radioactive anomalies were detected over LANDSAT tonal anomalies.
3. The Gamma Ray Spectrometer does not appear useful in exploration for oil and gas in the Black Warrior Basin, Mississippi and Alabama.

APPENDIX A

Total Count Road Traverses

Line 1

Line 1 begins at the intersection of county road 13 and Mount Hope Church road, proceeding eastward. (Location A).

Range multiplier is set at 1 , gain is set at 4.8, function is set at TC - total count, and the speed is 10 mph.

Odometer Reading in Miles		Average Total Count Rate
0.0	Begin line 1	35
0.5		30
1.0		30
1.5	Enter highway 19 (Location C)	30
2.0		40
2.5		35
3.0		35
3.5		37
4.0		33
4.3	Turn left (southwest) at Liberty Church onto a dirt road (Location E)	
4.5		36
5.0		35
5.3	Cross gas pipeline	
5.5		32
6.0		33
6.5	Turn left (southwest) at stop sign	26
7.0		21
7.1	Gain adjusted to 5.3	
7.5		27
8.0		31
8.2	Turn left (south) at Mount Hope Church (Location H)	
8.5		24
8.9	Completion of line 1 at the starting point of line 1. Gain is readjusted to 5.4	25

Line 2

Line 2 begins at the intersection of county road 13 and unnamed dirt road originating at SW/4, SE/4, SW/4 of Section 12, proceeding northward.

Range multiplier is set at 1 , gain is set at 5.4, function is set at TC - total count, and speed is 10 mph.

Odometer Reading in Miles		Average Total Count Rate
0.0	Begin survey (Location B)	21
0.5		22
0.8	End survey (Location F)	20

Line 3

Line 3 begins at a north-south oriented road originating at $E/4, $E/4, SE/4 of Section 2, proceeding northward.

Range multiplier is set at 1 , gain is set at 5.5, function is set at TC - total count, and speed is 10 mph.

Odometer Reading in Miles	Average Total Count Rate
0.0 Begin line 3 (Location G)	23
0.5	25
0.8	50
1.0 End line 3 at the approximate border of Sections 2 and 35 (Location K)	30

Line 4

Line 4 begins at the intersection of highway 19 and an unnamed dirt road at SW SE SW of Section 7, proceeding eastward.

Range multiplier is set at 1 , gain is set at 5.4, function is set at TC - total count, and speed is 10 mph.

Odometer Reading in Miles	Average Total Count Rate
0.0 Begin Line 4 (Location D)	21
0.3	30
0.4	40
0.5 Timed reading taken (Location 10-see appendix B) Gained checked, kept at 5.4	45
Speed decreased to 5 mph	
0.6 Increases to 50 between 0.5-0.6 miles	35
0.7	30
0.8	35
0.9	36
1.0 Timed reading taken (Location 11-see appendix B) kept at 5,4	40
1.3	33
1.4	40
1.5 End of line 4 (Location J)	35

Turned around and surveyed back to the point of the first timed reading (0.5 mile mark). There were no significant changes in the total count rate. Another timed reading was taken at this point. For the reading taken see appendix B.

Line 5

Line 5 begins at the intersection of highway 19 and an unnamed dirt road beginning at SE/4 SW/4 SE/4 of Section 13, proceeding northward.

Odometer Reading in Miles	Average Total Count Rate
0.0 Count increase to 40 between 0.0-0.1 miles (Location C)	28
0.1 Count increase to 40 between 0.1-0.2 miles	30
0.2 Count increase to 42 between 0.2-0.3 miles	38
0.3	35
0.4 Count increase to 40 between 0.4-0.5 miles	35
0.5 Count increase to 45 between 0.5-0.6 miles	38
0.6	35
0.7 Count increase to 42 between 0.7-0.8 miles	33
0.8	31
0.9 Count increase to 40 between 0.9-1.0 miles	32
1.0 End of line 5 (Location I)	34

APPENDIX B

Specific Elemental Contributions

To Total Gamma Radioactivity

		Total Count		Potassium (K)		Uranium (Bi)		Thorium (τι)			Ratio Uranium/Thorium
Sample Period		Count Rate	%	Count Rate	%	Count Rate	%	Count Rate	%		
10 sec.		45	100%	29	64.4%	9	20.0%	7	15.6%		1.29
1 min.		278	100%	199	60.5	73	22.2	57	17.3%		1.28
4 min.		1133	100%	803	60.4	320	24.1	206	15.5%		1.55
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RESULTS OF SPECTROMETER TEST AT LOCATION 1

		Total Count		Potassium (K)		Uranium (Bi)		Thorium (Tl)			Ratio Uranium/Thorium
Sample Period		Count Rate	%	Count Rate	%	Count Rate	%	Count Rate	%		
10 sec.		36	100%	12	41.4% 33.3%	9	31.0% 25.0%	8	27.6% 22.2%		1.13
1 min.		217	100%	106	51.5% 48.9%	61	29.6% 28.1%	39	18.9% 18.0%		1.56
4 min.		808	100%	387	52.9% 47.9%	214	29.3% 26.5%	130	17.8% 16.1%		1.65
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RESULTS OF SPECTROMETER TEST AT LOCATION 2

Sample Period		To Lal Count Count Rate	%	Potassium (K) Count Rate	%	Uranium (Bi) Count Rate	%	Thorium (τι) Count Rate	%		Ratio Uranium/Thor ium
■ - 10 sec.		51	100%	26	44.1%	13	22.0%	20	33.9%		.65
10 sec.		45	100%	27	50.0%	18	33.3%	9	16.6%		2.0
10 sec.		48	100%	25	43.1%	21	36.2%	12	20.7%		1..75
10 sec.		46	100%	24	55.8%	14	32.6%	5	11.6%		2.8
Averages		47.5	100%	25.5	47.7%	16.5	30.8%	11.5	21.5%		1.8
1 min.		279	100%	141	47.3%	95	31.9%	62	20.8%		1.53
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RESULTS OF SPECTROMETER TEST AT LOCATION 3

		Total Count		Potassium (K)		Uranium (Bi)		Thorium (Tl)			Ratio Uranium/Thor ium
Sample Period		Count Rate	%	Count Rate	%	Count Rate	%	Count Rate	%		
10 sec.		38	100%	20	52.6%	11	29.0%	7	10.8%		1.57
10 sec.		36	100%	13	46.4%	6	21.4% 16.7%	9	32.2% 25.0%		0.66
10 sec.		38	100%	14	60.8%	6	26.1% 15.8%	3	13.1% 7.9%		2.0
Average		37.3	100%	15.7	52.8%	7.7	25.9%	6.3	21.3% 17.0%		1.41
1 min.		223	100%	100	51.1% 49.3%	66	30.7% 29.6%	39	18.2% 17.5%		1.69

RESULTS OF SPECTROMETER TEST AT LOCATION 4

		To tal Count		Potassium (K)		Uranium (Bi)		Thorium (Tl)			Ratio Uranium/Thor ium
Sample Period		Count Rate	%	Count Rate	%	Count Rate	%	Count Rate	%		
10 sec.		42	100%	13	43.3%	7	43.3% 16.7%	10	23.3% 23.8%		0.70
10 sec.		44	100%	26	52.0%	13	26.0%	11	22.0%		1.18
10 Sec.		45	100%	17	41.4%	19	46.3% 42.2%	5	12.3%		3.8
Average		43.7	100%	18.7	46.3%	13.0	32.2%	8.7	21.5%		1.89
1 min.		258	100%	151	50.7%	88	29.5%	59	19.8%		1.49

RESULTS OF SPECTROMETER TEST AT LOCATION 5

		Total Count		Potassium (K)		Uranium (Bí)		Thorium (Tl)			Ratio Uranium/Thor ium
Sample Period		Count Rate	%	Count Rate	%	Count Rate	%	Count Rate	%		
10 sec.		33	100%	16	48.5%	13	39.4%	4	12.1%		3.25
10 sec.		38	100%	16	47.0%	13	38.2%	5	14.8%		2.60
10 sec.		33	100%	19	65.5%	6	20.7%	4	13.8%		1.5
Averages		34.7	100%	17.0	53.1%	10.7	33.4%	4.3	13.4%		2.45
1 min.		206		73	44.0%	50	30.1% 24.3%	43	25.9% 25.9%		1.16
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RESULTS OF SPECTROMETER TEST AT LOCATION 6

		Total Count		Potassium (K)		Uranium (Bi)		Thorium (Tl)			Ratio Uranium/Thorium
Sample Period		Count Rate	%	Count Rate	%	Count Rate	%	Count Rate	%		
10 sec.		36	100%	14	58.3%	4	16.7% 11-1%	6	25.0% 16.7%		.66
10 sec.		33	100%	15	55.6%	5	18.5%	7	25.9%		.71
1 O . .		37	100%	13	46.4%	6	21.4%	9	32.2%		.67
Average		35.3	100%	14.0	53.2%	5.0'	19.0%	7.3	27.8%		.68
1 min.		219	100%	94	46.3%	68	33.5%	41	20.2%		1.66

RESULTS OF SPECTROMETER TEST AT LOCATION 7

		To tal Count		Po tassium (K)		Uranium (Bi)		Thorium (Tl)			Ratio Uranium/Thor ium
Sample Period		Count Rate	%	Count Rate	%	Count Ra te	%	Count Rate	%		
10 sec.		45	100%	18	46.2% 40.0%	13	33.3% 28.9%	8	20.5% 17.8%		1.63
10 sec.		41	100%	18	47.3%	11	28.9%	9	23.8%		1.22
10 sec.		39	100%	16	43.2%	12	32.4%	9	24.4%		1.33
Average		41.7	100%	17.3	45.5%	12.0	31.6%	8.7	22.9%		1.39
1 min.		239	100%	132	56.2% 55.2%	65	27.7% 27.2%	38	16.1% 15.9%		1.71

RESULTS OF SPECTROMETER TEST AT LOCATION 8

		Total Count		Potassium (K)		Uranium (Bi)		Thorium (Tl)			Ratio Uranium/Thorium
Sample Period		Count Rate	%	Count Rate	%	Count Rate	%	Count Rate	%		
10 sec.		39	100%	12	41.4%	9	31.0%	8	27.6%		1.13
10 sec.		37	100%	13	52.0%	4	16.0%	8	32.0%		0.50
10 sec.		34	100%	16	59.3%	6	22.2%	5	18.5%		1.2
Average		36.6	100%	13.7%	50.7%	6.3	23.3%	7.0	26.0%		0.94
1 min.		234	100%	85	45.7%	61	32.8%	40	21.5%		1.53

RESULTS OF SPECTROMETER TEST AT LOCATION 9

		Total Count		Potassium (K)		Uranium (Bi)		Thorium (Tl)			Ratio Uranium/Thorium
Sample Period		Count Rate	%	Count Rate	%	Count Rate	%	Count Rate	%		
10 sec.		60	100%	26	40.6%	25	39.1%	13	20.3%		1.9
10 sec.		58	100%	29	49.2%	17	28.8%	13	22.0%		1.3
10 sec.		61	100%	30	45.5%	19	28.8%	17	25.8%		1.1
Average		59.7	100%	28.3	45.0%	20/3	32.3%	14.3	22.8%		1.4
1 min.		362	100%	172	50.6% 47.5%	106	31.2% 29.3%	62	18.2% 17.1%		1.7

RESULTS OF SPECTROMETER TEST AT LOCATION 10

		Total Count		Potassium (K)		Uranium (Bi)		Thorium (Tl)			Ratio Uranium/Thor ium
Sample Period		Count Rate	%	Count Rate	%	Count Rate	%	Count Rate	%		
10 sec.		41	100%	25	50.0%	14	28.0%	11	22.0%		1.27
10 sec.		38	100%	13	41.9%	12	38.7%	5	16.1%		2.40
10 sec.		39	100%	20 58	60.6%	8 34	24.2%	5 21	15.2%		1.60
Averages		39.3	100%	19.3	51.3%	11.3	30.1%	7	18.6%		1.76

RESULTS OF SPECTROMETER TEST AT LOCATION 11

		Total Count		Potassium (K)		Uranium (Bí)		Thorium (Tl)			Ratio Uranium/Thorium
Sample Period		Count Rate	%	Count Rate	%	Count Rate	%	Count Rate	%		
10 sec.		57	100%	19	38.0%	18	36.0%	13	26.0%		1.38
10 sec.		55	100%	27	52.9%	19	37.3%	5	9.8%		3.80
10 sec.		57	100%	34 80	42.5%	28 65	35.0%	18 36	22.5%		1.56
Averages		56.3	100%	26.6	44.2%	21;7	35.9%	12	19.9%		2.25

RESULTS OF SPECTROMETER TEST AT LOCATION 12

		Total Count		Po tassium (K)		Uranium (Bi)		Thorium (Tl)			Ratio Uranium/Thorium
Sample Period		Count Rate	%	Count Rate	%	Count Rate	%	Count Rate	%		
10 sec.		27	100%	8	40.0%	5	25.0%	7	35.0%		.71
10 sec.		26	100%	8 8	42.1% 30.8%	8	42.1% 30.8%	3	15.8% 11.5%		2.67
10 sec.		26	100%	7 23	43.8%	3 16	18.8%	6 16	37.5%		.50
Averages		26.3	100%	7.7	41.8% 29.1%	5.3	29.1%	5.3	29.1%		1.29

RESULTS OF SPECTROMETER TEST AT LOCATION 13

		Total Count		Potassium (K)		Uranium (Bi)		Thorium (Tl)			Ratio Uranium/Thorium
Sample Period		Count Rate	%	Count Rate	%	Count Rate	%	Count Rate	%		
10 sec.		31	100%	10	54.6%	4	21.9%	3	16.4%		1.33
10 sec.		28	100%	13	65.0%	3	15.0%	4	20.0%		.75
10 sec.		31	100%	12 35	54.5%	6 13	27.3%	4 11	18.2%		1.5
Averages		30.0	100%	11.7	59.3%	4.3	22.0%	3.7	18.6%		1.19

RESULTS OF SPECTROMETER TEST AT LOCATION 14

		Total Count		Potassium (K)		Uranium (Bi)		Thorium (τι)			Ratio Uranium/Thoriurn
Sample Period		Count Rate	%	Count Rate	%	Count Rate	%	Count Rate	%		
10 sec.		36	100%	17	60.7%	5	17.9%	6	21.4%		.83
10 sec.		40	100%	20	48.8%	12	29.3%	9	22.0%		1.33
10 sec.		36	100%	17 54	45.9% 47.2%	9 26	24.3%	11 26	29.7%		.82
Averages		37.3	100%	18.0	51.4%	8.0	24.8%	8.7	24.8%		.99

RESULTS OF SPECTROMETER TEST AT LOCATION 15

		Total Count		Potassium (K)		Uranium (Bi)		Thorium (Tl)			Ratio Uranium/Thorium
Sample Period		Count Rate	%	Count Rate	%	Count Rate	%	Count Rate	%		
10 sec.		37	100%	14	28.0%	8	26.7%	4	26.7%		.50
10 sec.		38	100%	19	38.0%	8	26.7%	5	33.3%		1.60
10 sec.		41	100%	17 50	34.0%	14 30	46.7%	6 15	40.0%		2.33
Averages		38.7	100%	16.7	52.6%	10.0	31.6% 25.9%	5.0	15.8%		1.48

RESULTS OF SPECTROMETER TEST AT LOCATION 16

		Total Count		Potassium (K)		Uranium (Bi)		Thorium (Tl)			Ratio Uranium/Thorium
Sample Period		Count Rate	%	Count Rate	%	Count Rate	%	Count Rate	%		
10 sec.		30	100%	10	45.5%	12	60.0%	7	63.6%		1.71
10 sec.		30	100%	12 22	54.5%	8 20	40.0%	4 11	36.4%		2.0
Averages		30	100%	11.0	41.5%	10.0	37.7%	5.5	20.8%		1.24
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RESULTS OF SPECTROMETER TEST AT LOCATION 17

		To tal Count		Potassium (K)		Uranium (Bi)		Thorium (Tl)			Ratio Uranium/Thorium
Sample Period		Count Rate	%	Count Rate	%	Count Rate	%	Count Rate	%		
10 sec.		36	100%	18	35.3%	7	35.0%	8	36.4%		.88
10 sec.		39	100%	18	35.3%	4	20.0%	8	36.4%		.50
10 sec.		35	100%	15 51	29.4%	9 20	45.0%	6 22	27.3%		1.5
Averages		36.7	700%	77.0	54.8%	6.7	27.5%	7.8	7 8.7%		.Q6

RESULTS OF SPECTROMETER TEST AT LOCATION 18