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URANIUM AND THORIUM DATA FOR SELECTED PRECAMBRIAN ROCK UNITS IN NORTHERN WISCONSIN

by

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ANALYTICAL DATA FOR URANIUM AND THORIUM IN SELECTED PRECAMBRIAN ROCK UNITS IN WISCONSIN

Gregory Mursky[1], James W. Anderson[1], Timothy R. Cook[1], and William S. Meddaugh[1]

ABSTRACT

The article summarizes the results of uranium and thorium investigations, by gamma-ray spectrometry, of several Precambrian rock units in Wisconsin.

The highest values were encountered in the Wolf River batholith where uranium values range from less than 1 ppm to more than 30 ppm; thorium values range from less than 5 ppm to more than 50 ppm. The mean value for uranium is 6 ppm and for thorium 24 ppm with a Th/U ratio of 4.2. The highest uranium and thorium values are found in the younger, more differentiated units of the batholith.

The Ninemile Pluton in Marathon County contains uranium concentrations between less than 1 ppm and 15.6 ppm with a mean value of 1.6 ppm; the range for thorium was between 12.1 ppm and 56.4 ppm and a mean of 21.2 ppm. The high Th/U ratio, with an averagge value of 12 indicates that uranium may have been preferentially leached during weathering. Middle Proterozoic quartzite- metaconglomerate units in northeastern and northwestern parts of Wisconsin show a range of uranium concentrations from less than 1 ppm to 5 ppm and a mean value of 1.5 ppm. The thorium concentrations range from less than 1 ppm to 32 ppm with a mean value of 5.4 ppm. The mean Th/U ratio is nearly 4. These ranges and averages are well within the normal values for similar rock types found in the literature.

INTRODUCTION

Uranium and thorium are present in trace amounts in almost all geological materials as minor constituents in the lithosphere. Taylor (1964) calculates that the average concentration of uranium in the earth crust amounts to

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1.8 ppm (parts per million) and that of thorium 7.2 ppm. Uranium and thorium may occur in several ways in rock: in radioactive accessory minerals such as uraninite, thorite, monazite, zircon, and allanite; as isomorphic substitutions in the crystal lattice of such minerals as sphene, apatite, niobates, tantalates, and titanates; as molecular or ionic disseminations in, or associated with, the major rock-forming minerals; and as entrapments in lattice imperfections, along fractures and cleavage planes, along grain boundaries, or as fluid inclusions.

Each atom of uranium and thorium decays through discrete transformations and characteristic half-lives by the emission of several alpha and beta particles and gamma rays to form daughter products which are different than the parent element (figs. 1 and 2). Among the products of radioactive decay of uranium and thorium are radium and radon, which are considered to be health hazards. Radium-226, which is a product of decay of uranium-238, is of special concern because if has a relatively long half life (1620 years) and high specific activity. The human body metabolizes radium in much the same way as calcium whereby radium-226 becomes concentrated in bones. The United States Environmental Protection Agency (EPA) recommends that the amount of radium in drinking water not exceed 5 pCi/L (picocuries per liter— one picocurie of radium equals 1×10^{-12} grams).

This article summarizes the results of three separate studies on the concentration of uranium and thorium in several different regions of Wisconsin, including granitic rock of Wolf River batholith, granitic rock, near Wausau, in Marathon County, and quartzite and metaconglomerate units in northeastern and northwestern parts of Wisconsin.

The commentary on the data are published separately (Mursky and others, 1988) in *Geoscience Wisconsin Volume 13.*

ANALYTICAL TECHNIQUES

Whole Rock Uranium and Thorium Analysis

Whole-rock uranium and thorium concentrations in parts- per-million (ppm) were determined by the gamma spectrographic technique utilizing the method given by Adams and Gasparini (1970), and used by Meddaugh (1978), Anderson (1979), and Cook (1980) for this study.

The laboratory facility consists of a testing chamber, gamma-ray sensor, gamma analyzer, timing unit, and digital printer and display unit (fig. 3). The gamma-ray sensor, and 1852 cm3 (15.2 by 10.2 cm) NaI crystal detector with an attached photomultiplier tube assembly (Scintrex Model GSA-61), was enclosed in a testing chamber constructed of 5-cm thick lead bricks. Two bricks on the top of the chamber are removable to allow insertion of samples into the chamber. The gamma sensor is connected to the electronics of the gamma analyzer - a differential, four channel, pulse- height discriminator (Scintrex Model GAM-1). A timing unit, LED digital display, and printer unit are connected to the gamma analyzer in such a way that the number of counts accumulated in a single channel is printed after a preselected time interval.

The channels viewed by the pulse-height discriminator are centered on 2.6 MeV, ^{208}Tl photopeak of the Th-232 decay series, with a window width of

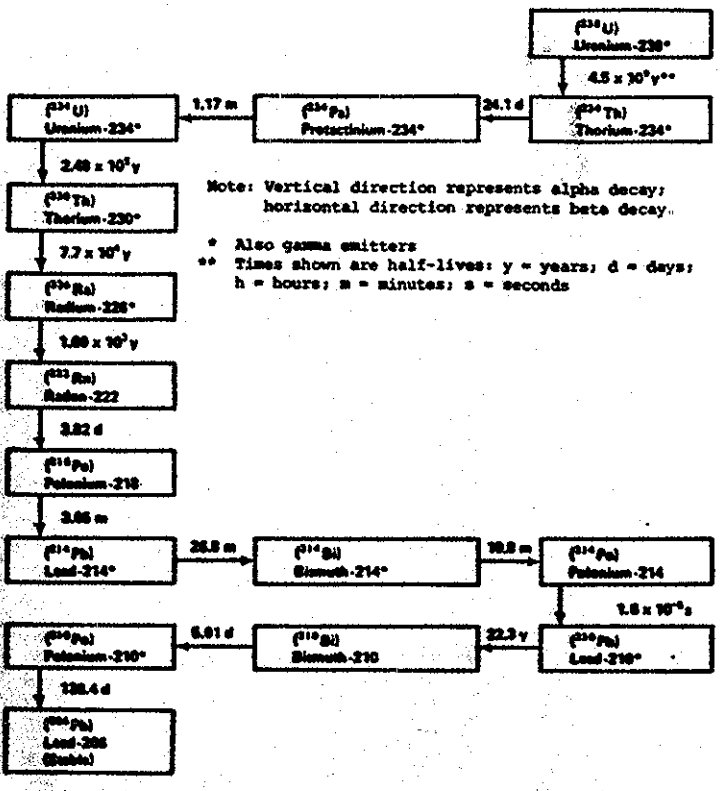

Figure 1. The radioactive decay series for uranium-238.

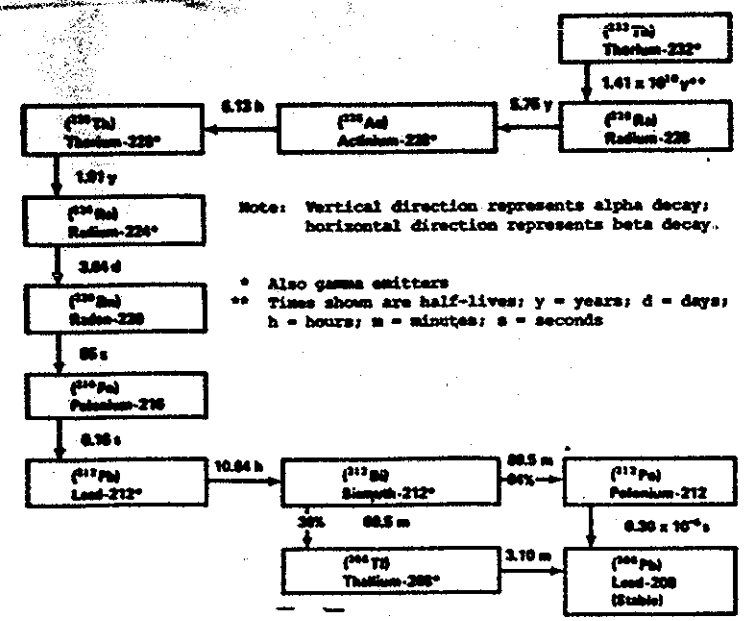

Figure 2. The radioactive decay series of thorium-232.

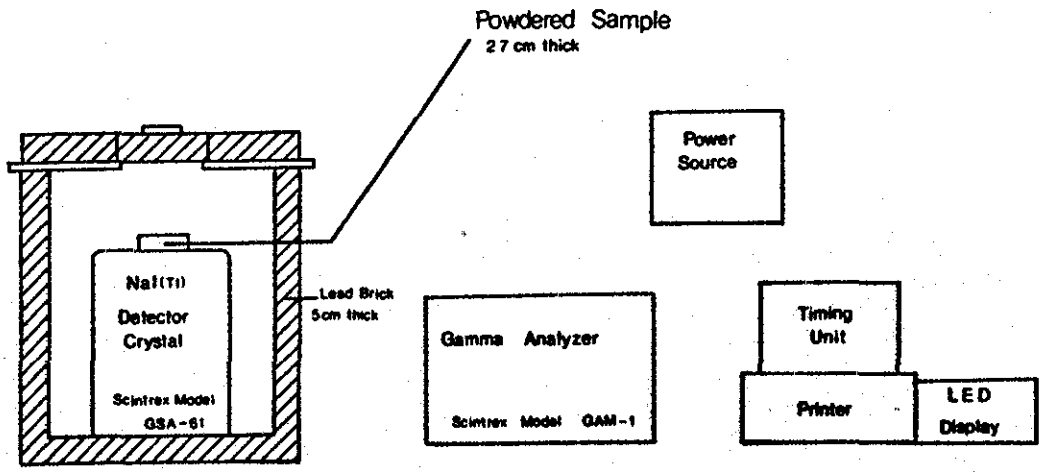

Figure 3. Schematic diagram of the gamma-ray spectrometer facility used to analyze rock samples for uranium and thorium.

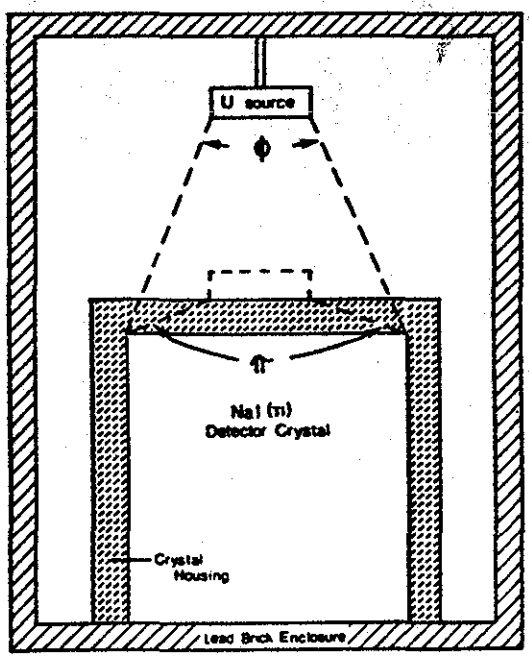

Figure 4. Source-detector configuration for the determination of the stripping ratio (s), thorium and uranium concentration factors (Q_{Th}, Q_U, and height correction factor (h).

approximately 0.26 MeV (Th channel), and 1.76 MeV, ^{214}Bi photopeak of the U-238 decay series, with a window width of approximately 0.19 MeV (U channel).

If the samples to be analyzed are in secular equilibrium (a not unreasonable assumption for this study) and the contribution to the Th channel from the U-238 decay series is negligible (except when U>>Th), then the following equations, modified from Adams and Gasparini (1970), can be used to calculate the equivalent Th and U values for a given sample:

$$eTh(ppm) = \frac{RTh - BGTh}{m\ (QTh)\ h}$$

and

$$eU(ppm) = \frac{RU - BGU - (S(RTh - BGTh))}{m\ (QU)\ h}$$

where
- eTh(ppm) = equivalent thorium in parts per million;
- eU(ppm) = equivalent uranium in parts per million;
- RTh = observed count rate (cps) in the Th channel;
- RU = observed count rate (cps) in the U channel;
- BGTh = background count rate (cps) in the Th channel;
- BGU = background count rate (cps) in the U channel;
- QTh = concentration factor for Th (cps/ppm)/kg;
- QU = concentration factor for U (cps/ppm)/kg;
- S = stripping ratio;
- m = mass of sample (kg); and
- h = height correction factor.

All of the variables in the above equation except RTh, RU, and m are constants and must be evaluated for a particular laboratory before analysis of samples commences.

Background count rates in the Th and U channels were measured inside the testing chamber several times daily for a period of four weeks prior to testing, and checked periodically throughout the study. Instrument stability was obtained when the source was suspended 14.7 cm above the center of the detector housing, and this configuration (fig. 4) was used for determination of S, QTh, and QU.

The uranium and thorium concentration factors QU and QTh equate samples with known mass and concentration in ppm to unknown samples and are determined using the following equation (modified from Adams and Gasparini, 1970):

$$QTh,\ U = (cps/ppm)/kg$$

The concentration factors were evaluated using the Canadian Radioactive Ore Standard DH-1. A sample container was filled with 0.114 kg of the powdered standard and sealed. The standard was then suspended above the detector housing and tested in the same manner as the unknown samples.

All of the rock samples analyzed were placed directly on the detector housing; thus, a height correction factor, h, was needed to maintain the source-detector geometry when the S, QTh, and QU values were calculated. The value of h is simply the ratio of the solid angles seen by the detector crystal when the samples are suspended and when they are directly on the detector housing (fig. 4). The value of h was then calculated from h = pi/psi. The accuracy of the h value was checked by analyzing 0.106 kg of powdered Canadian Radioactive Ore Standard DL-1 (83 ppm Th, 41 ppm U) in the same manner as the unknown samples. Values for eU and eTh were determined to be 41 5.6 ppm and 73 5.7 ppm respectively. Both of the above values are within the statistical accuracy obtained at the lower concentrations of U and Th encountered in the unknown samples; thus, the value of h is considered to be accurate.

In order to be able to compare U and Th concentrations for the various samples a uniform testing procedure must be followed. Source - detector geometry and separation, sample thickness and diameter must be kept constant. Large samples provide more gamma-ray emitters and improve statistical accuracy of the concentrations in ppm; thus, sample containers were chosen that were as large as practical.

A large number of accumulated counts is necessary to keep statistical errors due to fluctuations in sample and background decay rates to a minimum. Counting statistics and associated errors are discussed by Adams and Gasparini (1970) and Loevinger and Berman (1951). Reduced source- detector separation increases the number of gamma-rays interacting with the detector crystal; therefore, samples were placed directly on the gamma-ray sensor housing.

Sample Preparation and Testing

All rock samples were crushed, seived to a size of less than 2mm, and placed into 8.0 cm diameter by 2.7 cm deep tin containers. Containers of this size were chosen because they are large enough in diameter and shallow enough in depth to accommodate a fairly large sample (0.187 to 0.250 kg) without introducing a serious problem of self-absorption of gamma-rays. The containers were then made air-tight by sealing the joint between the can and the top with plastic tape.

Samples were stored for a minimum of 45 days prior to testing to re-establish secular equilibrium of the gaseous daughter product (radon) of the ^{238}U and ^{232}Th decay series that was probably released during crushing. Sealing of the containers assured a buildup of the gaseous daughters in the container and a more uniform equilibrium state after the 45-day storage period.

Before analysis of the samples the gamma analyzer had to be energy calibrated in order to accurately locate the 2.62 MeV Tl208 photopeak. Calibration was accomplished by placing a pure thorium source (sample TS-3 provided by Scintrex Inc.) into the testing chamber 14.7 cm inches) above the detector housing and then following the procedure described in the Scintrex GAM-1 Instruction Manual (1974). The energy calibration did not drift significantly in a 10-hour period, so re-calibration was performed once daily. Samples were analyzed during the day hours; however, the scintillation counter remained on continuously throughout the study to avoid warm-up stability problems.

After calibration the samples were placed into the testing chamber in direct contact with the gamma sensor housing and allowed to accumulate counts

for a minimum of 70 minutes (>7000 counts). The exact number of counts accumulated during a precise amount of time was recorded and used to determine the count rate for the sample. Analysis of a single sample in both the U and Th channels typically required 140 minutes to complete.

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APPENDIX I

OUTCROP RADIOACTIVITY, AND URANIUM, AND THORIUM DATA FOR WOLF RIVER BATHOLITH

SAMPLE NUMBER	LOCATION	UNIT[1]	TOTAL COUNT RADIOACTIVITY OUTCROP (cps)	TOTAL COUNT RADIOACTIVITY LABORATORY (cps/kg)	LABORATORY U (ppm)	LABORATORY Th (ppm)	Th/U
002	SW1/4,Sec.14,T31N,R16E	BGc	---	41.5	3.5	7.4	2.1
030	NE1/4,Sec.14,T25N,R13E	WP	---	56.2	3.3	20.6	6.3
044	NE1/4,Sec. 3,T27N,R14E	WR	---	76.6	7.7	21.4	2.8
045	NE1/4,Sec.32,T28N,R14E	RR	---	91.3	14.4	25.4	1.8
062	NE1/4,Sec.25,T33N,R18E	PM	---	41.4	2.4	13.2	5.5
100	SW1/4,Sec.30,T30N,R17E	PC	120	----	---	---	---
101	NW1/4,Sec. 5,T30N,R17E	BGc	280	----	---	---	---
102	SW1/4,Sec.36,T31N,R16E	BGc	230	53.7	4.1	16.3	4.0
103	SE1/4,Sec.35,T31N,R16E	BGc	255	----	---	---	---
104	SE1/4,Sec.35,T31N,R16E	BGf	270	73.9	6.0	28.8	4.8
105	SE1/4,Sec.35,T31N,R16E	BGf	270	----	---	---	---
106	SE1/4,Sec. 5,T30N,R17E	BGc	220	70.6	5.8	28.1	4.8
107	SW1/4,Sec.36,T31N,R16E	BGc	175	47.1	3.2	17.4	5.3
108	SW1/4,Sec.36,T30N,R17E	BGc	190	----	---	---	---
109	SE1/4,Sec.36,T31N,R16E	BGc	225	----	---	---	---
110	NE1/4,Sec. 5,T30N,R17E	BGc	220	----	---	---	---

SAMPLE NUMBER	LOCATION	UNIT[1]	TOTAL COUNT RADIOACTIVITY OUTCROP (cps)	TOTAL COUNT RADIOACTIVITY LABORATORY (cps/kg)	LABORATORY U (ppm)	LABORATORY Th (ppm)	LABORATORY Th/U
111	NE1/4,Sec. 5,T30N,R17E	BGc	220	----	---	---	---
112	SW1/4,Sec.31,T31N,R17E	BGc	195	----	---	---	---
113	SW1/4,Sec.31,T31N,R17E	BGc	175	77.3	4.3	20.0	4.6
114	NW1/4,Sec.31,T31N,R17E	BGc	220	83.2	2.3	25.7	11.2
115	NW1/4,Sec.31,T31N,R17E	BGc	220	----	---	---	---
116	SE1/4,Sec.25,T31N,R16E	BGc	310	87.9	10.2	25.0	2.5
117	SW1/4,Sec.25,T31N,R16E	BGc	320	----	---	---	---
118	SW1/4.Sec.25,T31N,R16E	BGc	380	----	---	---	---
119	SE1/4,Sec.25,T31N,R16E	BGc	360	----	---	---	---
120	SE1/4,Sec.25,T31N,R16E	BGcp	480	213.	7.7	116.	15.0
121	SE1/4,Sec.25,T31N,R16E	BGc	360	91.1	9.0	35.8	4.0
122	SW1/4,Sec.19,T31N,R17E	BGc	285	81.9	14.5	37.1	2.6
123	SE1/4,Sec.24,T31N,R17E	BGc	260	76.5	5.7	20.3	3.6
124	SW1/4,Sec.23,T31N,R16E	BGc	145	----	---	----	---
125	SW1/4,Sec.11,T31N,R16E	BGf	480	152.	19.2	45.7	2.4
126	SW1/4,Sec.11,T31N,R16E	BGf	480	126.	14.8	38.0	2.6

SAMPLE NUMBER	LOCATION	UNIT[1]	TOTAL COUNT RADIOACTIVITY OUTCROP (cps)	TOTAL COUNT RADIOACTIVITY LABORATORY (cps/kg)	LABORATORY U (ppm)	LABORATORY Th (ppm)	LABORATORY Th/U
127	NE1/4,Sec.14,T31N,R16E	BGf	260	76.5	5.7	20.3	3.6
128	NE1/4,Sec.14,T31N,R16E	BGf	280	----	---	---	---
129	SW1/4,Sec.14,T31N,R16E	BGc	220	----	---	---	---
130	NW1/4,Sec.14,T31N,R16E	BGc	220	63.6	5.1	16.8	3.3
131	NW1/4,Sec.14,T31N,R16E	BGf	320	----	---	---	---
132	NW1/4,Sec.11,T31N,R16E	BGf	320	----	---	---	---
133	SW1/4,Sec. 6,T31N,R17E	HFP	210	----	---	---	---
134	NW1/4.Sec. 6,T31N,R17E	HFP	240	----	---	---	---
135	NW1/4,Sec. 6,T31N,R17E	HFP	270	56.1	3.6	24.1	6.8
136	SW1/4,Sec. 6,T31N,R17E	PC	60	----	---	---	---
137	NW1/4,Sec.32,T32N,R17E	HG	200	----	---	---	---
138	NE1/4,Sec.32,T32N,R17E	HG	220	55.1	9.2	17.9	2.0
139	NE1/4,Sec.32,T32N,R17E	HG	220	87.7	7.1	20.6	2.9
140	SW1/4,Sec.22,T32N,R17E	HFP	190	----	---	---	---
141	SE1/4,Sec.22,T32N,R17E	HFP	220	----	---	---	---
142	NW1/4,Sec.22,T32N,R17E	HS	220	----	---	---	---

SAMPLE NUMBER	LOCATION	UNIT[1]	TOTAL COUNT RADIOACTIVITY OUTCROP (cps)	TOTAL COUNT RADIOACTIVITY LABORATORY (cps/kg)	LABORATORY U (ppm)	LABORATORY Th (ppm)	LABORATORY Th/U
143	SE1/4,Sec. 7,T30N,R17E	WR	235	----	---	---	---
144	SE1/4,Sec. 7,T30N,R17E	WR	205	----	---	---	---
145	SE1/4,Sec. 7,T30N,R17E	WR	270	74.1	6.9	16.9	2.5
146	NE1/4,Sec. 7,T30N,R17E	WR	240	52.3	4.1	17.1	4.2
147	NE1/4,Sec.24,T31N,R16E	PM	115	35.0	1.5	8.6	5.4
148	NW1/4,Sec.22,T31N,R17E	BGc	210	----	---	---	---
149	NW1/4,Sec.22,T31N,R17E	BGc	160	----	---	---	---
150	NW1/4.Sec.22,T31N,R17E	PC	60	----	---	---	---
151	NW1/4,Sec.22,T31N,R17E	BGc	180	----	---	---	---
152	NW1/4,Sec.20,T31N,R17E	BGf	275	----	---	---	---
153	NW1/4,Sec.20,T31N,R17E	BGf	380	----	---	---	---
154	NW1/4,Sec.20,T31N,R17E	BGf	390	83.1	7.9	22.3	2.8
155	NW1/4,Sec.20,T31N,R17E	BGf	200	----	---	---	---
156	NW1/4,Sec.20,T31N,R17E	PC	110	----	---	---	---
157	NW1/4,Sec.20,T31N,R17E	BGf	285	86.9	8.2	29.7	3.6
158	NE1/4,Sec.22,T31N,R16E	PM	75	32.1	1.2	6.3	5.4

SAMPLE NUMBER	LOCATION	UNIT[1]	TOTAL COUNT RADIOACTIVITY OUTCROP (cps)	TOTAL COUNT RADIOACTIVITY LABORATORY (cps/kg)	LABORATORY U (ppm)	LABORATORY Th (ppm)	LABORATORY Th/U
159	NE1/4,Sec.22,T31N,R16E	PM	60	----	---	---	---
160	SW1/4,Sec.18,T31N,R17E	PM	120	----	---	---	---
161	SW1/4,Sec.14,T31N,R16E	BGc	320	61.0	5.1	14.1	2.7
163	SW1/4,Sec.14,T31N,R16E	PM	110	----	---	---	---
164	NE1/4,Sec.16,T31N,R16E	BGc	210	----	---	---	---
165	SE1/4,Sec.16,T31N,R16E	BGc	220	----	---	---	---
166	SW1/4,Sec.16,T31N,R16E	BGc	220	53.0	2.2	19.1	8.6
167	NW1/4.Sec.26,T31N,R15E	WRp	320	77.1	0.8	50.2	high
168	NW1/4,Sec.26,T31N,R15E	WR	240	----	---	---	---
169	NE1/4,Sec.31,T31N,R15E	WR	180	52.5	4.5	13.3	3.0
170	SW1/4,Sec. 2,T31N,R16E	HG	275	55.6	5.2	11.2	2.1
171	NE1/4,Sec. 1,T31N,R16E	HFP	215	52.6	5.3	20.2	3.8
172	NE1/4,Sec. 1,T31N,R16E	HFP	210	41.2	2.6	17.6	6.7
173	SW1/4,Sec.22,T32N,R17E	HG	320	55.9	10.6	18.6	1.8
174	NW1/4,Sec.24,T32N,R17E	HFP	190	86.4	ND[2]	17.1	high
175	NW1/4,Sec.24,T32N,R17E	HFP	240	----	---	---	---

SAMPLE NUMBER	LOCATION	UNIT[1]	TOTAL COUNT RADIOACTIVITY OUTCROP (cps)	TOTAL COUNT RADIOACTIVITY LABORATORY (cps/kg)	LABORATORY U (ppm)	LABORATORY Th (ppm)	LABORATORY Th/U
176	NW1/4,Sec. 1,T32N,R18E	BGc	280	----	---	---	---
177	SW1/4,Sec.26,T33N,R18E	BGc	225	59.0	4.5	19.5	4.4
178	NW1/4,Sec. 1,T32N,R18E	BGc	265	36.4	5.8	15.9	2.8
179	NW1/4,Sec.25,T33N,R18E	PM	125	----	---	---	---
180	NE1/4,Sec.20,T32N,R16E	HS	175	----	---	---	---
181	SW1/4,Sec.14,T32N,R16E	HS	165	----	---	---	---
181a	SW1/4,Sec.14,T32N,R16E	HS	165	51.0	2.0	19.0	9.7
182	SW1/4.Sec. 6,T27N,R15E	RR	380	115.	14.0	34.1	2.4
183	SW1/4,Sec. 6,T27N,R15E	RR	415	----	---	---	---
184	SW1/4,Sec. 6,T27N,R15E	RRp	620	----	---	---	---
185	SE1/4,Sec. 2,T27N,R14E	RR	320	----	---	---	---
186	SW1/4,Sec. 8,T27N,R15E	RR	300	98.3	11.9	30.6	2.6
187	NE1/4,Sec. 3,T27N,R14E	RR	280	----	---	---	---
188	NE1/4,Sec.32,T28N,R14E	WR	220	----	---	---	---
189	SE1/4,Sec.28,T28N,R13E	WR	180	44.1	4.5	11.1	2.6
190	SE1/4,Sec.28,T28N,R13E	WRp	430	----	---	---	---

SAMPLE NUMBER	LOCATION	UNIT[1]	TOTAL COUNT RADIOACTIVITY OUTCROP (cps)	TOTAL COUNT RADIOACTIVITY LABORATORY (cps/kg)	LABORATORY U (ppm)	LABORATORY Th (ppm)	LABORATORY Th/U
191	SW1/4,Sec.28,T28N,R13E	M	140	30.3	0.9	10.0	11.
192	SW1/4,Sec.28,T28N,R13E	M	150	----	---	---	---
193	NE1/4,Sec. 1,T27N,R12E	WRa	320	107.	20.6	21.8	1.3
194	NW1/4,Sec.22,T27N,R12E	WRa	320	----	---	---	---
195	NW1/4,Sec.22,T27N,R12E	WRa	280	157.	37.4	23.0	0.6
196	NW1/4,Sec.22,T27N,R12E	AN	70	23.3	ND[2]	4.3	high
197	NE1/4,Sec.24,T27N,R12E	WR	150	----	---	---	---
200	SE1/4.Sec.20,T27N,R14E	RR	320	70.0	5.8	24.4	4.2
201	NE1/4,Sec. 8,T26N,R14E	RR	420	----	---	---	---
202	SE1/4,Sec. 6,T26N,R14E	RR	320	90.1	8.5	37.2	4.4
203	SE1/4,Sec. 6,T26N,R14E	RR	360	93.1	10.7	34.9	3.3
204	NE1/4,Sec. 2,T25N,R13E	WR	260	----	---	---	---
205	NE1/4,Sec. 2,T25N,R13E	WRa	860	151.	22.7	69.2	3.1
207	SW1/4,Sec.11,T25N,R13E	RR	410	130.	10.2	41.6	4.1
208	NE1/4,Sec.20,T25N,R13E	RR	620	----	---	---	---
209	NE1/4,Sec.20,T25N,R13E	WR	220	----	---	---	---

SAMPLE NUMBER	LOCATION	UNIT[1]	TOTAL COUNT RADIOACTIVITY OUTCROP (cps)	TOTAL COUNT RADIOACTIVITY LABORATORY (cps/kg)	LABORATORY U (ppm)	LABORATORY Th (ppm)	Th/U
210	NE1/4,Sec.20,T25N,R13E	PC(?)	180	----	---	---	---
211	NE1/4,Sec.20,T25N,R13E	RR	420	----	---	---	---
212	NE1/4,Sec.20,T25N,R13E	PC(?)	180	----	---	---	---
214	NE1/4,Sec.20,T25N,R13E	RRav	120	----	---	---	---
215	NE1/4,Sec.20,T25N,R13E	RR	260	----	---	---	---
216	NE1/4,Sec.20,T25N,R13E	RR	340	81.9	8.9	32.6	3.7
217	NE1/4,Sec.20,T25N,R13E	RRm	960	702.	185.	153.	0.9
219	NE1/4.Sec.20,T25N,R13E	RR	220	----	---	---	---
220	NE1/4,Sec.19,T25N,R13E	WR	280	----	---	---	---
221	NE1/4,Sec.19,T25N,R13E	RR	420	111.	13.7	42.8	3.1
222	SE1/4,Sec.18,T25N,R13E	RR	400	148	11.7	45.4	3.9
223	NW1/4,Sec.18,T25N,R13E	RR	325	----	---	---	---
224	NW1/4,Sec.18,T25N,R13E	RR	300	----	---	---	---
225	NW1/4,Sec.18,T25N,R13E	RR	420	----	---	---	---
226	NW1/4,Sec.18,T25N,R13E	RR	320	73.6	4.3	26.2	6.1
227	NW1/4,Sec.18,T25N,R13E	RR	280	----	---	---	---

SAMPLE NUMBER	LOCATION	UNIT[1]	TOTAL COUNT RADIOACTIVITY OUTCROP (cps)	TOTAL COUNT RADIOACTIVITY LABORATORY (cps/kg)	LABORATORY U(ppm)	LABORATORY Th(ppm)	LABORATORY Th/U
228	NE1/4,Sec.13,T25N,R12E	RR	360	118.	12.0	42.1	3.6
229	SE1/4,Sec.13,T25N,R12E	RR	360	104.	12.0	34.6	2.9
230	NW1/4,Sec.24,T25N,R12E	RR	350	----	---	---	---
231	SE1/4,Sec.23,T25N,R12E	RR	375	98.1	7.4	34.9	4.7
232	SE1/4,Sec.23,T25N,R12E	RR	390	----	---	---	---
233	SW1/4,Sec.23,T25N,R12E	RR	450	104.	21.0	18.2	0.9
234	NW1/4,Sec.23,T25N,R12E	RR	250	----	---	---	---
235	NE1/4.Sec.22,T25N,R12E	RR	300	75.8	7.3	24.7	3.4
236	SE1/4,Sec.15,T25N,R12E	RR	320	----	---	---	---
237	NW1/4,Sec.14,T25N,R12E	RR	335	88.7	7.2	40.7	5.6
238	SW1/4,Sec.11,T25N,R12E	RR	400	95.2	10.3	42.2	4.1
239	SE1/4,Sec.11,T25N,R12E	RR	470	110.	10.5	40.7	3.9
240	SW1/4,Sec.26,T26N,R12E	WR(?)	360	115.	2.7	24.7	9.1
242	SE1/4,Sec.16,T27N,R14E	RR	290	115.	8.7	39.9	4.6
243	NE1/4,Sec.22,T27N,R13E	WR	260	----	---	---	---
244	NE1/4,Sec.22,T27N,R13E	WRa	580	----	---	---	---

SAMPLE NUMBER	LOCATION	UNIT[1]	TOTAL COUNT RADIOACTIVITY OUTCROP (cps)	TOTAL COUNT RADIOACTIVITY LABORATORY (cps/kg)	LABORATORY U(ppm)	LABORATORY Th(ppm)	LABORATORY Th/U
245	SW1/4,Sec.15,T27N,R13E	WP	305	85.2	3.1	35.6	11.
246	SW1/4,Sec.15,T27N,R13E	WP	260	88.4	9.0	35.6	3.9
247	SW1/4,Sec.15,T27N,R13E	WP	260	----	---	---	---
248	SW1/4,Sec.21,T27N,R13E	WRd	155	29.5	0.3	4.7	14.
249	NW1/4,Sec.23,T27N,R12E	WR	180	----	---	---	---
250	NE1/4,Sec.26,T27N,R12E	WR	210	55.7	11.6	15.1	1.3
251	NE1/4,Sec.26,T27N,R12E	WR(?)	210	80.1	6.4	40.6	6.3
252	SE1/4.Sec.30,T27N,R13E	WR	310	53.2	5.4	23.3	4.4
253	SE1/4,Sec.24,T27N,R12E	M	130	----	---	---	---
254	NW1/4,Sec.23,T27N,R12E	AN	80	----	---	---	---
255	NW1/4,Sec.23,T27N,R12E	WR	220	----	---	---	---
256	NW1/4,Sec.23,T27N,R12E	WR	220	----	---	---	---
257	NE1/4,Sec.12,T27N,R12E	WP	260	106.	6.0	45.2	7.5
258	NE1/4,Sec. 8,T26N,R12E	WP	310	119.	10.0	49.5	5.0
259	NW1/4,Sec.17,T26N,R12E	WR	240	----	---	---	---
260	NW1/4,Sec.13,T26N,R12E	WR	170	48.2	4.8	13.4	2.8

SAMPLE NUMBER	LOCATION	UNIT[1]	TOTAL COUNT RADIOACTIVITY OUTCROP (cps)	TOTAL COUNT RADIOACTIVITY LABORATORY (cps/kg)	LABORATORY U(ppm)	LABORATORY Th(ppm)	LABORATORY Th/U
261	NW1/4,Sec.27,T26N,R12E	WP	270	----	---	---	---
262	NE1/4,Sec.27,T26N,R12E	WP	360	65.4	4.8	29.4	6.1
263	NE1/4,Sec.27,T26N,R12E	WP	240	72.2	0.8	15.8	high
264	NW1/4,Sec.22,T26N,R12E	WP	260	57.8	8.3	26.1	3.2
265	NW1/4,Sec.22,T26N,R12E	WPm	---	244.	49.1	82.1	1.7
266	NW1/4,Sec.22,T26N,R12E	WP	260	----	---	---	---
267	NW1/4,Sec.22,T26N,R12E	WP	320	89.2	7.2	47.7	6.6
268	NW1/4.Sec.22,T26N,R12E	WP	---	92.9	4.8	39.5	8.2
269	NW1/4,Sec.22,T26N,R12E	WP	220	----	---	---	---
270	SW1/4,Sec. 9,T26N,R12E	WP	215	----	---	---	---
271	SW1/4,Sec. 9,T26N,R12E	WP	220	----	---	---	---
272	SW1/4,Sec. 9,T26N,R12E	WPp	820	----	---	---	---
273	NW1/4,Sec.15,T26N,R12E	WR	150	45.6	0.9	4.0	4.3
274	NW1/4,Sec.15,T26N,R12E	WR	290	----	---	---	---
275	NE1/4,Sec.15,T26N,R12E	RR(?)	400	86.5	3.4	33.5	9.9
276	NE1/4,Sec.15,T26N,R12E	WP(?)	170	----	---	---	---

SAMPLE NUMBER	LOCATION	UNIT[1]	TOTAL COUNT RADIOACTIVITY OUTCROP (cps)	TOTAL COUNT RADIOACTIVITY LABORATORY (cps/kg)	LABORATORY U(ppm)	LABORATORY Th(ppm)	LABORATORY Th/U
277	SW1/4,Sec.14,T26N,R12E	WR	170	40.0	0.3	11.8	high
278	SW1/4,Sec.14,T26N,R12E	RR	400	----	---	---	---
279	NE1/4,Sec.15,T26N,R12E	WP	230	65.6	6.8	28.7	4.2
280	NW1/4,Sec.14,T26N,R12E	RR	560	123.	13.9	46.3	3.3
281	NW1/4,Sec.14,T26N,R12E	WP	270	----	---	---	---
282	NW1/4,Sec.14,T26N,R12E	RR	400	142.	32.2	31.9	1.0
283	NW1/4,Sec.14,T26N,R12E	RR	460	146.	10.3	59.3	5.8
284	NE1/4.Sec.34,T28N,R14E	WR	195	----	---	---	---
285	SW1/4,Sec.11,T27N,R14E	RR	320	86.5	11.3	41.5	3.7
286	NE1/4,Sec.27,T28N,R14E	WR	325	68.4	6.3	25.8	4.1
287	NE1/4,Sec.21,T28N,R14E	WR	195	57.8	3.0	10.6	3.5
288	NW1/4,Sec.10,T27N,R13E	WR	280	50.4	4.2	13.9	3.3
289	NE1/4,Sec. 6,T27N,R13E	WR(?)	335	147.	33.1	26.2	0.8
290	NE1/4,Sec.24,T28N,R 9E	WR	145	----	---	---	---
291	SE1/4,Sec. 7,T29N,R10E	WR	155	----	---	---	---
292	SE1/4,Sec. 5,T29N,R10E	WR	155	----	---	---	---

SAMPLE NUMBER	LOCATION	UNIT[1]	TOTAL COUNT RADIOACTIVITY OUTCROP (cps)	TOTAL COUNT RADIOACTIVITY LABORATORY (cps/kg)	LABORATORY U(ppm)	LABORATORY Th(ppm)	LABORATORY Th/U
293	NE1/4,Sec.32,T30N,R10E	WRd	160	52.1	1.2	4.9	4.0
294	NE1/4,Sec.20,T29N,R10E	WR	155	----	---	---	---
296	NW1/4,Sec.22,T25N,R12E	RR	440	----	---	---	---
297	NW1/4,Sec.22,T25N,R12E	RR	400	75.9	3.9	24.6	6.1
298	NE1/4,Sec.22,T25N,R12E	RR	400	----	---	---	---
313	NE1/4,Sec. 8,T26N,R12E	WP	270	----	---	---	---
314	SE1/4,Sec. 5,T26N,R12E	WR	200	49.5	3.0	15.6	5.1
315	NW1/4.Sec. 2,T26N,R12E	WR	180	37.3	1.5	4.4	2.9
316	NW1/4,Sec.11,T26N,R12E	WR	175	64.7	3.8	15.8	4.1
317	SE1/4,Sec.11,T26N,R12E	RR	490	119.	9.4	35.6	3.8
318	SE1/4,Sec.11,T26N,R12E	RR	380	94.8	6.0	40.2	3.6
319	SW1/4,Sec.12,T26N,R12E	WR	340	----	---	---	---
320	SW1/4,Sec.12,T26N,R12E	RR	420	99.0	11.0	46.4	4.2
321	SW1/4,Sec.22,T22N,R12E	WQM	160	----	---	---	---
322	NE1/4,Sec.22,T22N,R12E	WQM	180	133.	5.0	55.8	10.1
323	SW1/4,Sec.11,T22N,R12E	WQM	200	----	---	---	---

SAMPLE NUMBER	LOCATION	UNIT[1]	TOTAL COUNT RADIOACTIVITY OUTCROP (cps)	TOTAL COUNT RADIOACTIVITY LABORATORY (cps/kg)	LABORATORY U(ppm)	LABORATORY Th(ppm)	LABORATORY Th/U
324	NE1/4,Sec. 5,T22N,R12E	WQM	190	----	---	---	---
325	NE1/4,Sec.35,T24N,R12E	WQM	340	106.	5.7	51.2	8.9
326	SW1/4,Sec.14,T24N,R12E	WR	95	----	---	---	---
327	NE1/4,Sec.35,T25N,R12E	WR	260	55.8	7.2	10.8	1.5
328	NW1/4,Sec.33,T25N,R12E	WRp	250	44.8	11.6	8.6	0.7
329	NW1/4,Sec.27,T25N,R12E	RR	470	----	---	---	---
330	SE1/4,Sec.22,T25N,R12E	RR	360	77.3	8.1	31.0	3.8
331	SE1/4,Sec.22,T25N,R12E	RR	360	----	---	---	---
332	SW1/4.Sec.23,T25N,R12E	RR	780	185.	31.8	48.6	1.5
333	SW1/4,Sec.23,T25N,R12E	RR	460	158.	23.2	35.9	1.6
334	SE1/4,Sec.11,T27N,R14E	RR	285	51.3	1.6	15.4	9.5
335	SW1/4,Sec.15,T26N,R14E	RR	295	82.2	5.1	23.6	4.3
336	NE1/4,Sec.12,T25N,R12E	RR	320	90.0	12.3	23.8	1.9
337	SW1/4,Sec. 7,T25N,R13E	RR	330	----	---	---	---
338	SW1/4,Sec. 7,T25N,R13E	RR	380	134.	12.8	49.1	3.8
339	NW1/4,Sec.18,T25N,R13E	RR	340	67.1	4.7	21.0	4.4

SAMPLE NUMBER	LOCATION	UNIT[1]	TOTAL COUNT RADIOACTIVITY OUTCROP (cps)	TOTAL COUNT RADIOACTIVITY LABORATORY (cps/kg)	LABORATORY U (ppm)	LABORATORY Th (ppm)	LABORATORY Th/U
340	NE1/4,Sec.26,T25N,R12E	RR	580	----	---	---	---
341	NE1/4,Sec.26,T25N,R12E	RR	340	----	---	---	---
342	NE1/4,Sec.26,T25N,R12E	RR	780	150.	21.2	38.6	1.8
343	NE1/4,Sec.26,T25N,R12E	RR(?)	420	58.3	6.8	8.0	1.2
344	NE1/4,Sec.26,T25N,R12E	RR	360	----	---	---	---
345	NE1/4,Sec.26,T25N,R12E	RR	600	----	---	---	---
346	NE1/4,Sec.26,T25N,R12E	RR	---	270.	32.7	129.	3.9
347	NE1/4,Sec.26,T25N,R12E	RR	---	293.	43.4	97.6	2.2
348	NE1/4.Sec.26,T25N,R12E	RR(?)	---	177.	12.1	75.4	6.2
349	NW1/4,Sec.26,T25N,R12E	WR	240	75.2	3.1	19.4	6.3
350	NW1/4,Sec.24,T25N,R12E	RR	360	----	---	---	---
359	NE1/4,Sec.15,T24N,R 8E	RR	220	----	---	---	---
360	NE1/4,Sec. 6,T24N,R 8E	RR	180	----	---	---	---
361	NE1/4,Sec. 6,T24N,R 8E	RR	360	----	---	---	---
362	NE1/4,Sec.32,T24N,R 8E	RR	280	76.8	7.0	27.4	3.9
363	NW1/4,Sec.23,T24N,R 8E	RR	260	----	---	---	---

SAMPLE NUMBER	LOCATION	UNIT[1]	TOTAL COUNT RADIOACTIVITY OUTCROP (cps)	TOTAL COUNT RADIOACTIVITY LABORATORY (cps/kg)	LABORATORY U(ppm)	LABORATORY Th(ppm)	LABORATORY Th/U
364	SE1/4,Sec.16,T24N,R 8E	RR	275	----	---	---	---
365	NE1/4,Sec.16,T24N,R 8E	RR	260	----	---	---	---

[1]The following abbreviations have been used for the units of the Wolf River Batholith:

AN	-	anorthosite	PM	-	Peshtigo monzonite
M	-	monzonite	HG	-	Hager granite
RR	-	Red River quartz monzonite	HFP	-	Hager feldspar porphyry
WP	-	wiborgite porphyry	HS	-	Hager syenite
WR	-	Wolf River granite	WQM	-	Waupaca quartz monzonite
BGc	-	Belongia coarse granite			
BGf	-	Belongia fine granite	PC	-	Older Precambrain (1.5 b.y.) rocks

All samples are representative outcrop samples except as indicated by the following:

a	-	sample obtained from aplite dike or vein cutting the outcrop
p	-	sample obtained from pegmatite present at the outcrop
m	-	sample obtained from mafic-mineral rich zone at the outcrop
qv	-	sample obtained from quartz vein in the outcrop

[2]Not detected

APPENDIX II

LABORATORY URANIUM AND THORIUM RESULTS FOR NINEMILE PLUTON, MARATHON COUNTY

SAMPLE[1] NUMBER	LOCATION	LITHOLOGY[2]	LABORATORY U (ppm)	LABORATORY Th (ppm)	Th/U
1-1-0	SE1/4, Sec. 28, T.27N, R.6E	ag	1.3	20.1	15
1-1-5	"	"	5.2	16.3	3
1-1-10	"	"	5.3	19.8	4
1-1-15	"	"	1.5	20.7	14
1-2-0	"	"	2.8	19.6	7
1-2-5	"	"	3.4	19.9	6
1-2-5-L	"	ap	0.0	21.5	--
1-2-10	"	aq	4.9	14.1	3
1-2-15	"	"	2.0	24.2	12
1-2-20	"	"	1.1	21.7	20
1-2-25	"	"	1.5	21.7	14
2-1-0	NE1/4, Sec. 26, T.27N, R.6E	qs	0.0	56.4	--
2-1-5	"	"	0.0	21.1	--
3-1-0	NE1/4, Sec. 24, T.27N, R.6E	aq	2.0	24.7	12

SAMPLE[1] NUMBER	LOCATION	LITHOLOGY[2]	U (ppm)	LABORATORY Th (ppm)	Th/U
3-1-5	NE1/4, Sec. 24, T.27N, R.6E	ag	3.0	16.4	5
3-2-0	"	"	1.9	18.8	10
3-2-5	"	"	0.4	30.9	77
4-1-0	NE1/4, Sec. 12, T.26N, R.5E	qs	2.8	23.0	8
4-1-5	"	"	0.8	19.7	25
5-1-5	SE1/4, Sec. 36, T.26N, R.5E	qs	2.2	15.9	7
6-1-0	SW1/4, Sec. 13, T.27N, R.4E	gr	0.0	24.4	--
6-1-5-r	"	"	15.6	30.2	2
6-1-5	"	"	1.3	22.7	17
6-1-10	"	"	2.5	19.3	8
6-1-15	"	"	4.9	22.6	5
6-2-0	"	"	0.0	21.7	--
6-2-5	"	"	0.6	21.2	35

SAMPLE[1] NUMBER	LOCATION	LITHOLOGY[2]	LABORATORY U (ppm)	LABORATORY Th (ppm)	Th/U
6-2-15	SW1/4, Sec. 13, T.27N, R.4E	gr	4.0	23.9	6
6-3-0	"	"	0.8	20.1	25
6-3-5	"	"	2.1	20.9	10
7-1-0	NE1/4, Sec. 33, T.28N, R.6E	ag	0.5	19.2	38
7-1-5	"	"	0.0	19.8	--
7-1-5-r	"	"	1.4	19.7	14
7-1-10-r	"	"	4.2	38.6	9
7-1-15	"	"	0.0	30.8	--
7-2-0	"	"	4.8	19.5	4
7-2-5	"	"	2.0	17.8	9
7-3-15	"	"	3.0	16.3	5
8-1-0	NE1/4, Sec. 34, T.28N, R.6E	ag	0.4	32.3	81
8-1-5	"	"	0.6	25.4	42
8-1-10	"	"	0.8	24.9	31

SAMPLE[1] NUMBER	LOCATION	LITHOLOGY[2]	U (ppm)	LABORATORY Th (ppm)	Th/U
8-2-0	NE1/4, Sec. 34, T.28N, R.6E	aq	0.7	22.0	31
8-2-5	"	"	0.1	21.0	210
8-2-10	"	"	1.0	24.2	24
8-2-15	"	"	0.6	23.1	38
8-2-20	"	"	0.0	22.0	--
9-1-0	SE1/4, Sec. 34, T.28N, R.6E	ag	1.3	17.8	14
9-1-5	"	"	0.2	16.5	83
9-1-10	"	"	0.0	15.7	--
10-1-0	NW1/4, Sec. 2, T.27N, R.6E	ag	0.8	12.6	16
10-1-5	"	"	1.4	16.2	12
10-1-10	"	"	1.4	13.5	10
10-1-15	"	"	1.1	14.1	13
10-1-20	"	"	0.5	15.3	31
10-1-sp	"	ap	3.0	24.5	8

SAMPLE[1] NUMBER	LOCATION	LITHOLOGY[2]	LABORATORY U (ppm)	LABORATORY Th (ppm)	Th/U
10-2-0	NW1/4, Sec. 2, T.27N, R.6E	ag	0.6	15.3	26
10-2-5	"	"	0.1	15.8	158
10-2-10	"	"	0.3	14.3	48
11-1-0	SW1/4, Sec. 13, T.27N, R5E	ag	2.7	22.8	8
11-1-5	"	"	1.4	28.9	21
12-1-0	SW1/4, Sec. 44, T.28N, R.6E	ag	0.0	18.1	--
12-1-5	"	"	0.0	15.4	--
12-1-10	"	"	1.3	16.7	13
13-1-0	SW1/4, Sec. 18, T.27N, R.6E	ag	2.3	12.1	5
13-1-5	"	"	0.0	17.1	--
13-1-10	"	"	1.7	15.3	9
13-1-20	"	"	2.4	17.3	7
13-2-0	"	"	1.5	20.8	14
13-2-5-r	"	"	4.6	27.1	6

SAMPLE[1] NUMBER	LOCATION	LITHOLOGY[2]	LABORATORY U (ppm)	LABORATORY Th (ppm)	Th/U
13-2-10	SW1/4, Sec. 18, T.27N, R.6E	ag	0.0	27.7	--
13-2-15-r	"	"	2.3	23.4	10
13-3-0	"	qs	0.0	17.9	--
13-3-5	"	"	2.1	14.1	7
13-3-10	"	"	0.3	29.5	98
13-3-15	"	"	0.3	23.0	77
13-4-0	"	"	1.3	13.8	11
13-4-5	"	"	0.0	16.9	--
13-4-10	"	"	0.0	15.9	--
13-4-15	"	"	0.0	14.3	--
13-4-25	"	"	0.6	14.8	25
13-4-30	"	"	0.6	19.1	32
13-4-40	"	"	0.8	14.6	18
13-4-45	"	"	0.3	16.1	54

SAMPLE[1] NUMBER	LOCATION	LITHOLOGY[2]	U (ppm)	LABORATORY Th (ppm)	Th/U
13-4-45-r	SW1/4, Sec. 18, T.27N, R.6E	aq	2.0	26.1	13
13-4-50	"	"	0.0	15.0	--
14-1-10	NE1/4, Sec. 12, T.27N, R.5E	qs	0.0	17.6	--
14-1-10-c	"	"	0.0	21.3	--
14-1-15	"	"	1.5	15.4	10
14-1-20	"	"	0.7	17.9	26
14-1-25	"	"	0.6	17.4	29
15-1-0	SW1/4, Sec. 20, T.27N, R.6E	qs	0.2	17.6	88
15-1-5	"	"	1.9	18.2	10
15-1-10	"	"	1.8	21.7	12
15-1-15	"	"	1.9	16.4	9
15-2-0	"	"	0.0	19.8	--
15-2-5	"	"	0.2	18.8	94
15-2-10	"	"	0.0	18.5	--

SAMPLE[1] NUMBER	LOCATION	LITHOLOGY[2]	U (ppm)	LABORATORY Th (ppm)	Th/U
15-2-15	SW1/4, Sec. 20, T.27N, R.6E	qs	4.2	20.2	5
15-2-20	"	"	2.2	19.7	9
15-2-25	"	"	0.4	22.6	57
15-3-0	SE1/4, Sec. 19, T.27N, R.6E	qs	4.6	17.9	4
15-3-5	"	"	1.2	16.6	14
15-3-10-r	"	"	3.4	18.9	6
15-3-15	"	"	1.4	19.9	14
16-1-0	NE1/4, Sec. 29, T.29N, R.6E	qs	0.5	18.3	37
16-1-5	"	"	2.0	20.9	10
16-1-20	"	"	0.0	18.7	--
16-1-25-r	"	"	6.7	26.3	4
16-1-30-r	"	"	1.8	31.0	17
16-2-0	"	"	0.3	20.4	68
16-2-15	"	"	1.8	18.9	11

SAMPLE[1] NUMBER	LOCATION	LITHOLOGY[2]	LABORATORY U(ppm)	LABORATORY Th(ppm)	Th/U
16-2-20	NE1/4, Sec. 29, T.27N, R.6E	qs	3.6	14.7	4
16-2-20-r	"	"	5.6	36.3	6
16-2-30	"	"	1.1	16.0	15
17-1-5	SW1/4, Sec. 6, T.27N, R.6E	qs	0.0	32.3	--
17-1-20	"	"	0.5	23.7	47
17-1-30	"	"	1.2	24.0	20
17-1-30-r	"	"	2.7	35.1	13
17-1-35	"	"	1.4	20.9	15
17-1-50	"	"	0.6	22.0	37
17-2-0	"	"	0.0	19.3	--
17-2-5	"	"	0.0	19.7	--
17-2-10	"	"	0.0	19.7	--
17-2-15	"	"	0.0	20.2	--
17-2-20	"	"	0.4	20.4	51

SAMPLE[1] NUMBER	LOCATION	LITHOLOGY[2]	U (ppm)	LABORATORY Th (ppm)	Th/U
17-2-25	SW1/4, Sec. 6, T.27N, R.6E	qs	2.5	22.1	9
17-2-25-r	"	"	2.6	28.0	11
17-3-0	"	"	3.0	21.9	7
17-3-5	"	"	0.0	24.2	--
17-3-10	"	"	0.5	22.1	44
17-3-15-r	"	"	0.6	22.9	38
18-1-0	SW1.4, Sec. 32, T.28N, R.6E	qs	2.5	24.1	10
18-1-5	"	"	2.4	19.6	8
18-1-10	"	"	3.1	19.4	6
18-1-20	"	"	0.2	14.9	75
18-1-25-r	"	"	8.8	24.6	3
18-1-30	"	"	3.0	23.8	8
19-1-0	SE1/4, Sec. 7, T.27N, R.6E	ag	0.0	19.3	--
19-1-5	"	"	0.1	15.7	157

SAMPLE[1] NUMBER	LOCATION	LITHOLOGY[2]	LABORATORY U (ppm)	LABORATORY Th (ppm)	Th/U
19-1-10-r	SE1/4, Sec. 7, T.27N, R.6E	ag	2.5	13.5	5
20-1-0	SW1/4, Sec. 27, T.27N, R.6E	qs	1.7	27.2	16
20-1-5	"	"	0.7	37.3	53
20-1-10	"	"	4.2	28.2	7
21-1-0	NW1/4, Sec. 19, T27.N, R.6E	qs	0.0	33.7	--
21-1-5	"	"	0.3	22.9	76
21-1-10	"	"	1.5	17.5	12
22-1-0	NE1/4, Sec. 24, T.27N, R.5E	qs	4.1	25.6	6
22-1-5	"	"	3.0	24.5	8
22-1-10	"	"	2.0	24.4	12
22-1-15	"	"	1.4	25.0	18
Well Cuttings[3]					
260758 (83-84')	SW1/4, Sec. 32, T.29N, R.7E	gr	3.4	16.2	5

SAMPLE[1] NUMBER	LOCATION	LITHOLOGY[2]	LABORATORY U (ppm)	LABORATORY Th (ppm)	LABORATORY Th/U
289044 (70-75')	NE1/4, Sec. 1, T.26N, R.6E	qs	0.0	5.06	--
278144 (48-49')	NE1/4, Sec. 12, T.28N, R.4E	gr	0.8	8.7	11
(60-65')	"	"	0.0	12.9	--
73Mr153 (21-26')	SE1/4, Sec. 12, T.28N, R.4E	gr	1.2	2.4	2
(31-35')	"	"	0.0	14.9	--
(75-80')	"	"	3.4	10.6	3
(100-105')	"	"	0.0	17.0	--
(120-125')	"	"	1.5	4.9	3
(200-180')	"	"	0.0	11.5	--
(200-205')	"	"	0.0	10.4	--

[1]Sample number explained as follows: quarry number - profile number - depth of sample (in feet) below the surface (ex. 22-1-5) -r indicates fresh rock samples

[2]Lithologic abbreviations are as follows:

ag - alkali granite (Nine Mile Granite)

qs - alkali quartz svenite (NMG)

ap - granite aplite (NMG)

gr - undifferentiated Middle Precambrian granite

[3]-sample number -
(depth interval from which well cuttings were taken)

APPENDIX III

OUTCROP RADIOACTIVITY AND URANIUM AND THORIUM DATA FOR MIDDLE PRECAMBRIAN QUARTZITES AND METACONGLOMERATES

SAMPLE* NUMBER	OUTCROP** NUMBER	LOCATION	TOTAL COUNT RADIOACTIVITY OUTCROP (cps)	TOTAL COUNT RADIOACTIVITY LABORATORY (cps/kg)	LABORATORY Th(ppm)	LABORATORY U(ppm)	LABORATORY Th/U
Mt 100	1	NE1/4,NE1/4,Sec6,T31N,R17E	57	33	9.1	1.9	4.8
Mt 101	6	NE1/4,NE1/4,Sec6,T31N,R17E	83	34	8.3	1.9	4.4
Mt 102	9	NW1/4,NE1/4,Sec6,T31N,R17E	70	32	7.2	1.9	3.8
Mt 103	7	NE1/4,NE1/4,Sec6,T31N,R17E	76	31	8.5	2.9	2.9
Mt 104	10	NW1/4,NE1/4,Sec6,T31N,R17E	157	39	12.0	1.8	6.7
Mt 105	11	NW1/4,SW1/4,Sec6,T31N,R17E	76	32	8.7	2.2	4.0
Mt 106	12	NW1/4,SW1/4,Sec6,T31N,R17E	78	35	8.4	2.6	3.2
Mt 107	13	NW1/4,SW1/4,Sec6,T31N,R17E	72	50	13.8	3.2	4.3
Mt 108	16	SW1/4,NW1/4,Sec6,T31N,R17E	63	27	5.2	1.8	2.9
Mt 109	18	NW1/4,NE1/4,Sec6,T31N,R17E	63	36	6.1	2.1	2.9
Mt 110	19	NE1/4,NE1/4,Sec6,T31N,R17E	113	40	10.9	2.8	3.9
Mt 111	20	NE1/4,NE1/4,Sec6,T31N,R17E	68	28	5.0	2.2	2.3

SAMPLE* NUMBER	OUTCROP** NUMBER	LOCATION	TOTAL COUNT RADIOACTIVITY OUTCROP (cps)	TOTAL COUNT RADIOACTIVITY LABORATORY (cps/kg)	LABORATORY Th (ppm)	LABORATORY U (ppm)	LABORATORY Th/U
Mt 112	21	NE1/4,NE1/4,Sec6,T31N,R17E	262	80	16.2	3.2	5.1
TM 114	25	SW1/4,SE1/4,Sec30,T33N,R18E	---	12	4.4	1.1	4.0
TM 115	25	SW1/4,SE1/4,Sec30,T33N,R18E	---	---	3.8	1.6	2.4
TM 116	26	SW1/4,SW1/4,Sec30,T33N,R18E	---	9	4.9	2.6	1.9
TM 117	27	SE1/4,NW1/4,Sec31,T33N,R18E	---	11	4.5	1.4	3.2
TM 118	28	NW1/4,NE1/4,Sec31,T33N,R18E	---	9	4.3	0.9	4.8
TM 119	29	NW1/4,NE1/4,Sec31,T33N,R18E	4	6	1.9	1.2	1.6
TM 120	30	NW1/4,NE1/4,Sec31,T33N,R18E	11	17	6.1	2.8	2.2
TM 121	31	NW1/4,NE1/4,Sec31,T33N,R18E	12	9	3.9	3.2	1.2
TM 122	31	NW1/4,NE1/4,Sec31,T33N,R18E	12	16	8.1	1.5	5.4
TM 123	32	SE1/4,NW1/4,Sec30,T33N,R18E	6	3	3.3	0.3	11.0
TM 124	33	C,SW1/4,NE1/4,Sec30,T33N,R18E	10	10	5.1	0.6	8.5

SAMPLE* NUMBER	OUTCROP** NUMBER	LOCATION	TOTAL COUNT RADIOACTIVITY OUTCROP (cps)	TOTAL COUNT RADIOACTIVITY LABORATORY (cps/kg)	LABORATORY Th(ppm)	LABORATORY U(ppm)	LABORATORY Th/U
McC 125	34	SEcnr,NW1/4,Sec4,T33N,R14E	---	4	1.6	0.2	8.0
McC 126	35	SW1/4,SW1/4,Sec3,T33N,R14E	110	16	5.9	1.3	4.5
McC 127	35	SW1/4,SW1/4,Sec3,T33N,R14E	110	40	17.9	3.5	5.1
McC 129	36	C,NE1/4,NE1/4,Sec5,T33N,R15E	14	12	4.8	1.3	3.7
McC 130	37	NEcnr,Sec5,T33N,R15E	11	37	21.5	0.9	23.9
McC 131	39	NE1/4,NE1/4,Sec5,T33N,R15E	4	10	3.3	1.5	2.2
McC 132	40	SE1/4,SE1/4,Sec32,T34N,R15E	27	19	9.2	1.3	7.1
McC 133	41	SW1/4,SE1/4,Sec32,T34N,R15E	18	7	2.9	0.9	3.2
McC 134	42	SW1/4,SE1/4,Sec32,T34N,R15E	---	7	2.4	0.5	4.8
McC 135	44	C,SW1/4,SE1/4,Sec32,T34N,R15E	9	20	9.0	1.2	7.5
McC 136	45	SW1/4,SE1/4,Sec32,T34N,R15E	---	8	2.0	1.6	1.3
McC 137	46	NE1/4,NE1/4,Sec5,T33N,R15E	---	8	3.2	0.7	3.9
McC 139	48	SW1/4,NW1/4,Sec4,T33N,R15E	9	11	2.7	1.4	1.9

SAMPLE* NUMBER	OUTCROP** NUMBER	LOCATION	TOTAL COUNT RADIOACTIVITY OUTCROP (cps)	TOTAL COUNT RADIOACTIVITY LABORATORY (cps/kg)	LABORATORY Th(ppm)	LABORATORY U(ppm)	LABORATORY Th/U
Gg 140	49	SEcnr,SW1/4,Sec27,T46N,R2E	98	24	0.0	3.6	0.0
Gg 141	50	SE1/4,SW1/4,Sec27,T46N,R2E	15	4	1.3	0.5	2.6
Gg 142	52	NE1/4,SE1/4,Sec32,T46N,R2E	155	25	7.4	1.9	3.9
Gg 143	53	NE1/4,SE1/4,Sec32,T46N,R2E	118	39	6.0	2.1	2.9
Gg 146	56	NWcnr,Sec5,T45N,R2E	128	36	7.4	1.9	3.9
Gg 147	57	SE1/4,NW1/4,Sec6,T45N,R2E	112	42	11.1	3.3	3.4
Gg 148	58	SW1/4,NW1/4,Sec6,T45N,R2E	154	20	4.1	1.0	4.1
Gg 149	59	SW1/4,NW1/4,Sec6,T45N,R2E	122	32	7.9	0.5	15.8
Gg 150	60	NEcnr,SE1/4,Sec19,T45N,R1E	54	11	1.2	3.2	0.0
Gg 151	61	NEcnr,SE1/4,Sec19,T45N,R1E	113	30	6.6	2.0	3.3
Gg 151	62	NEcnr,SE1/4,Sec19,T45N,R1E	110	22	5.8	2.2	2.6
Gg 153	63	NEncr,SE1/4,Sec19,T45N,R1E	107	52	4.3	0.7	6.1
Gg 154	64	NEncr,SE1/4,Sec19,T45N,R1E	150	41	8.8	1.6	5.5

SAMPLE* NUMBER	OUTCROP** NUMBER	LOCATION	TOTAL COUNT RADIOACTIVITY OUTCROP (cps)	TOTAL COUNT RADIOACTIVITY LABORATORY (cps/kg)	LABORATORY Th(ppm)	LABORATORY U(ppm)	LABORATORY Th/U
Ga 155	66	NWcnr,SW1/4,Sec20,T45N,R1E	33	11	0.0	2.2	0.0
Gg 156	68	SEcnr,NE1/4,Sec33,T45N,R1W	---	25	6.6	1.0	6.6
Ga 157	69	SWcnr,NW1/4,Sec34,T34N,R1W	117	28	8.4	3.0	2.8
Gg 158	70	SWcnr,NW1/4,Sec34,T45N,R1W	106	37	7.3	1.8	4.1
Gg 159	70	SWcnr,NW1/4,Sec34,T45N,R1W	106	20	5.5	2.2	2.5
Ga 160	71	SEcnr,NE1/4,Sec33,T45N,R1W	111	37	10.1	1.4	7.2
Ga 161	72	SEcnr,NE1/4,Sec33,T45N,R1W	4	6	0.0	0.0	0.0
Gg 163	73	NW1/4,NE1/4,Sec11,T44N,R2W	---	0	0.0	0.5	0.0
Ga 165	75	NW1/4,NE1/4,Sec11,T44N,R2W	105	34	6.6	1.8	3.7
Gg 168	79	SE1/4,NW1/4,Sec14,T44N,R3W	---	2	0.7	0.9	0.0
Ga 169	80	SE1/4,NW1/4,Sec14,T44N,R3W	123	34	10.1	3.0	3.4
Ga 171	82	C,NW1/4,NW1/4,Sec16,T44N,R2W	21	7	1.8	0.7	2.6
Gg 172	83	C,NW1/4,NW1/4,Sec16,T44N,R2W	116	38	9.5	0.2	47.5

SAMPLE* NUMBER	OUTCROP** NUMBER	LOCATION	TOTAL COUNT RADIOACTIVITY OUTCROP (cps)	TOTAL COUNT RADIOACTIVITY LABORATORY (cps/kg)	LABORATORY Th(ppm)	LABORATORY U(ppm)	LABORATORY Th/U
Gg 173	84	NWcnr,Sec6,T44N,R2W	84	46	11.5	1.5	7.7
Gg 174	85	NE1/4,NE1/4,Sec17,T44N,R2W	135	39	11.1	1.2	9.3
Gg 175	86	NEcnr,Sec17,T44N,R2W	96	30	7.2	2.4	3.0
Gg 176	87	SEcnr,Sec8,T44N,R2W	79	12	1.0	1.4	0.0
McC 177	88	SE1/4,NE1/4,Sec4,T33N,R15E	52	13	4.9	0.8	6.1
McC 178	89	SW1/4,NE1/4,Sec4,T33N,R15E	126	47	12.2	5.5	2.2
McC 179	91	C,SW1/4,NW1/4,Sec2,T33N,R15E	35	9	4.3	1.3	3.3
McC 180	92	SW1/4,NW1/4,Sec2,T33N,R15E	61	33	16.5	2.9	5.7
McC 181	93	NE1/4,NW1/4,Sec6,T33N,R16E	56	9	4.0	0.2	20.0
McC 182	94	NE1/4,NW1/4,Sec6,T33N,R16E	93	8	2.7	1.3	2.1
McC 183	95	NW1/4,NW1/4,Sec6,T33N,R16E	45	32	18.6	0.6	31.0
McC 184	96	NE1/4,MNW1/4,Sec6,T33N,R16E	46	12	6.3	0.4	15.8
McC 185	97	NE1/4,NW1/4,Sec6,T33N,R16E	40	9	5.4	0.8	6.8

SAMPLE* NUMBER	OUTCROP** NUMBER	LOCATION	TOTAL COUNT RADIOACTIVITY OUTCROP (cps)	TOTAL COUNT RADIOACTIVITY LABORATORY (cps/kg)	LABORATORY Th(ppm)	LABORATORY U(ppm)	LABORATORY Th/U
McC 186	98	SE1/4,SW1/4,Sec35,T34N,R16E	25	9	4.0	0.5	8.0
McC 187	99	SW1/4,SW1/4,Sec35,T34N,R16E	30	13	3.5	2.8	1.3
McC 188	100	C,SW1/4,NE1/4,Sec26,T34N,R16E	81	18	7.7	0.5	15.4
McC 189	101	NE1/4,NE1/4,Sec26,T34N,R16E	31	15	5.9	1.1	5.4
McC 190	102	C,NE1/4,Sec26,T34N,R16E	129	50	32.0	0.0	32.0
McC 191	103	NEcnr,Sec26,T34N,R16E	69	11	6.0	1.3	4.6
McC 192	104	NW1/4,NE1/4,Sec4,T33N,R16E	---	10	3.8	2.0	1.9
McC 193	105	SE1/4,NW1/4,Sec28,T34N,R17E	---	9	4.0	1.1	3.6
McC 194	107	NWcnr,Sec27,T34N,R17E	---	11	3.3	1.3	2.5
McC 195	108	SE1/4,SW1/4,Sec35,T34N,R16E	70	13	2.0	3.3	0.0
McC 196	109	C,SE1/4,Sec35,T34N,R16E	---	10	4.2	1.0	4.2
McC 197	110	SWcnr,NW1/4,Sec36,T34N,R16E	---	9	2.7	2.1	1.3
McC 198	111	SW1/4,NW1/4,Sec36,T34N,R16E	---	13	3.9	3.1	1.3

SAMPLE* NUMBER	OUTCROP** NUMBER	LOCATION	TOTAL COUNT RADIOACTIVITY OUTCROP (cps)	TOTAL COUNT RADIOACTIVITY LABORATORY (cps/kg)	LABORATORY Th(ppm)	LABORATORY U(ppm)	LABORATORY Th/U
McC 199	112	NE1/4,SE1/4,Sec35,T34N,R16E	---	10	1.5	2.5	0.0
Fla 200	113	NE1/4,NE1/4,Sec11,T32N,R7W	---	9	1.5	2.5	0.0
Fla 201	114	NE1/4,NE1/4,Sec11,T32N,R7W	5	15	3.6	0.0	3.6
Fla 202	115	NE1/4,SE1/4,Sec1,T32N,R7W	1	10	2.9	0.9	3.2
Fla 203	116	NE1/4,SE1/4,Sec1,T32N,R7W	---	11	6.0	0.0	6.0
Fla 204	117	NE1/4,SE1/4,Sec1,T32N,R7W	---	9	2.3	1.6	1.4
Fla 205	118	SWcnr,Sec6,T32N,R6W	---	7	1.3	0.1	13.0
Fla 207	120	SW1/4,SW1/4,Sec6,T32N,R6W	22	5	2.6	0.0	2.6
Fla 208	121	SE1/4,SE1/4,Sec1,T32N,R7W	7	9	2.3	0.8	2.9
Fla 209	122	NEcnr,SE1/4,Sec1,T32N,R7W	95	22	10.0	0.0	10.0
Fla 210	123	NW1/4,SW1/4,Sec6,T32N,R6W	29	11	2.2	0.4	5.5
Fla 211	124	C,NW1/4,Sec11,T32N,R7W	2	7	4.7	0.7	6.7
Fla 212	125	NE1/4,NW1/4,Sec11,T32N,R7W	3	11	7.9	0.1	79.0

SAMPLE* NUMBER	OUTCROP** NUMBER	LOCATION	TOTAL COUNT RADIOACTIVITY OUTCROP (cps)	TOTAL COUNT RADIOACTIVITY LABORATORY (cps/kg)	LABORATORY Th(ppm)	LABORATORY U(ppm)	LABORATORY Th/U
Fla 213	126	SE1/4,SW1/4,Sec2,T32N,R7W	---	9	2.6	0.8	3.3
Fla 214	127	SE1/4,SW1/4,Sec2,T32N,R7W	---	8	2.8	1.5	1.9
Fla 215	128	SWcnr,Sec2,T32N,R7W	1	9	1.2	1.1	1.1
Flo 216	129	NWcnr,Sec19,T39N,R18E	20	15	3.3	0.9	3.7
Flo 217	130	C,NW1/4,NW1/4,Sec19,T39N,R18E	43	14	6.1	2.0	3.1
Flo 218	131	NEcnr,Sec24,T39N,R17E	7	7	2.4	1.2	2.0
Flo 219	132	C,NE1/4,NW1/4,Sec19,T39N,R18E	16	11	2.0	1.2	1.7
Flo 220	133	NE1/4,NW1/4,Sec19,T39N,R18E	8	8	1.8	1.2	1.5
Flo 221	134	SE1/4,NE1/4,Sec19,T39N,R18E	20	11	2.8	1.0	2.8
Flo 222	135	C,SE1/4,NE1/4,Sec19,T39N,R18E	15	12	3.9	1.0	3.9
Flo 223	136	SE1/4,NE1/4,Sec19,T39N,R18E	16	8	5.1	1.0	5.1
Flo 224	137	NE1/4,NW1/4,Sec28,T39N,R18E	20	13	2.6	1.6	1.6
Flo 225	138	NE1/4,NW1/4,Sec28,T39N,R18E	25	19	4.1	3.6	1.1

SAMPLE* NUMBER	OUTCROP** NUMBER	LOCATION	TOTAL COUNT RADIOACTIVITY OUTCROP (cps)	TOTAL COUNT RADIOACTIVITY LABORATORY (cps/kg)	LABORATORY Th(ppm)	LABORATORY U(ppm)	LABORATORY Th/U
Flo 226	139	NW1/4,NW1/4,Sec28,T39N,R18E	20	11	0.9	1.6	0.0
Flo 227	140	SE1/4,SE1/4,Sec20,T39N,R18E	18	8	2.4	1.5	1.6
Flo 228	141	SE1/4,SE1/4,Sec20,T39N,R18E	11	7	2.1	1.2	1.8
Flo 229	142	SE1/4,SE1/4,Sec20,T39N,R18E	24	10	2.6	1.0	2.6
Flo 230	143	NWncr,Sec28,T39N,R18E	17	8	0.5	1.1	0.0
Flo 231	144	SWcnr,Sec21,T39N,R18E	17	12	3.7	1.4	2.6

* Mt = Samples collected from the Baldwin Conglomerate (Mountain area).

TM = Samples collected from the McCaslin Quartzite at Thunder Mountain.

McC = Samples collected from the McCaslin Quartzite from the McCaslin Range.

Gg = Samples collected from the Palms Quartzite (Gogebic area).

Fla = Samples collected from the Flambeau Quartzite (Barron area).

* Flo = Samples collected from the Pine River Quartzite-Conglomerate (Florence area).