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Interlaboratory Comparison of Analyses of Magnesium-rich Metamorphic Rocks and Uranium Ores by X-ray Fluorescence, Induction Coupled Plasma Spectroscopy, and Instrumental Neutron Activation

by

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with an Appendix on INAA quality control
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Background and Purpose

In 1980, the U.S. Geological Survey initiated a study of unconformity-vein uranium deposits as part of the National Uranium Resource Evaluation (NURE) program. This study was designed to describe examples of this important type of deposit (a deposit type known to occur only in Canada and Australia) and to develop ore deposit models as an aid to U.S. explorationists. As part of this study, samples of drill core were collected from the Ranger and Jabiluka orebodies, Northern Territory, Australia. These samples were analyzed for major elements by the U.S. Geological Survey utilizing X-ray fluorescence spectroscopy (XRF), and for some major and many minor and trace elements by the Nuclear Division of Oak Ridge National Laboratory utilizing inductively coupled plasma spectrography (ICP) and instrumental neutron activation analysis (INAA). Results of the chemical analyses for the samples collected at Ranger are published in Nash and Frishman (1983) along with a preliminary statistical interpretation of the chemistry of these rocks and ores. A summary of the geology in and around the Ranger orebodies can be found in Eupene and others (1975) and in Nash and Frishman (1982).

Subsequently, splits of some of the same sample powders submitted to Oak Ridge were resubmitted to Geological Survey laboratories for replicate ICP and INAA analysis and, additionally, for delayed neutron (DN) analyses for uranium and thorium. Nash and Frishman (1983) noted that there existed a number of ambiguities in the original data--ambiguities that remained unresolved because analytical results for the duplicate samples had not yet been received. The results of those additional analyses are listed in Appendix I, and this report evaluates those results and resolves as many of the ambiguities to which Nash and Frishman (1983) alluded as these data allow.

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Sampling and Sample Preparation

All samples used in this study came from diamond drill core. Drill hole localities are shown in Nash and Frishman (1982), and that paper also lists coordinates for the individual samples (corrected for drill hole drift) and provides generalized descriptions for the lithologies in and around the Ranger orebodies. Nash and Frishman (1983) include a lithologic code that describes each sample in terms of a lithologic/stratigraphic classification--those codes are included in Appendix I of this paper. Generally speaking, most of the samples used for this study were either relatively unaltered pelitic schists and gneisses or their chloritized and sericitized ($\pm$ mineralized) equivalents. Minor lithologies present include chloritized pegmatites, chloritized diabase dikes, both chloritized and unaltered dolomite and magnesite marbles, and chloritized quartz-rich sandstone. The uranium content of these rocks and ores ranges from 1.4 ppm to 3.7 percent.

Two types of drill core samples were collected; grab samples weighing from 50 to 400 grams and composite chip and chunk samples of a specific lithology collected from an interval of from 1 to 15 meters of core. The composite samples are identified with a "C" suffix on the sample ID and the depth given is to the top of the sample interval.

Most samples were crushed and ground in our own sample preparation lab; a few were prepared in another Geological Survey laboratory. A sample preparation code was assigned to each sample to indicate when and where each was processed and we have looked for, but not found, any systematic error that correlates with sample preparation (sample preparation codes are listed in Appendix I). No rock was ground more than once. That is, once a rock specimen was taken through the entire sample preparation procedure (described below), we never crushed another portion of the original hand specimen if additional material was required for subsequent analyses. All splits for additional analytical work were made from the quantity of sub-100 mesh powdered rock initially prepared so that all laboratories received splits processed in an absolutely identical manner.

Samples were processed in batches of from 10 to 40 samples (we originally prepared almost 800 samples - the 50 samples used for this comparative study are only a subset of the entire sample suite). Each batch was made up only of samples barren of uranium, only of moderately mineralized samples, or only of high-grade ore in order to minimize cross contamination. An attempt was also made to ensure that each batch was made up only of a single lithology (e.g. all pelitic lithologies or all carbonates). Grab samples of core were slabbed with a diamond saw, photographed, and one portion of the sample was sent for preparation of a polished thin section. The other portion was cleaned on a diamond grinding wheel to remove any contaminants (traces of metal from the core barrel or the diamond saw blade, china marker residue, etc.) and then crushed to pass 100 mesh using a jaw crusher, pulverizers with ceramic plates, and final hand grinding with a mortar and pestle. Chip samples were treated similarly except that some of those processed at the beginning of our sample preparation effort were not cleaned on the diamond wheel and we prepared thin sections of none of them. All crushing and grinding equipment was cleaned scrupulously between samples. For samples with preparation code 2 (the samples prepared in our laboratory - Appendix I), equipment was cleaned after every sample by scrubbing the equipment with a brush to remove all loose material, blowing it out with compressed air, washing with clean water, and finally blowing it dry, again with compressed air. All sample splitters used to divide sample powders were treated similarly.

Replicates and Reference Standards

We submitted 30 blind replicate samples and two blind USGS reference samples to Oak Ridge along with our "unknowns." The Oak Ridge analyses for the reference samples (standards BCR-1 and G-2) are published in Appendix II of Nash and Frishman (1983) and that paper also contains estimates of precision for the Oak Ridge analyses based on the 30 replicates. We did not submit blind replicates to the Geological Survey laboratories, but ratios of accepted values to determined values for a number of reference standards run along with the Survey INAA and ICP analyses are included here in Appendices II and III as tables A-1 and A-2, respectively.

Analytical Methods

Analyses performed at Oak Ridge National Laboratory were done using a Jarrel-Ash 1160[1] direct reading spectrograph with inductively coupled argon plasma source (ICP analyses) and equipment and procedures developed at that laboratory (INAA analyses). Solutions used for the ICP analyses were prepared by acid digestion. Details of the analytical procedures can be found in Cagle (1977), Bowman (1977) and Arendt and others (1980). XRF analyses were performed in Geological Survey laboratories using a Phillips PW1600[1] wave length dispersive simultaneous X-ray spectrometer; Survey ICP analyses utilized hardware similar to that used at Oak Ridge but different sample preparation and data reduction procedures. Samples again were prepared utilizing acid digestion, but the "ICP2" data set used a different digestion procedures than was used for the "ICP1" data (Appendix I). Geological Survey XRF and ICP analytical methods are described more fully in Taggart and others (1981). Crock and Lichte (1982) describe in-house modifications to the Survey ICP hardware. A more general discussion of the ICP technique can be found in Thompson and Walsh (1983).

Survey INAA procedures have not been published but are modifications of those described by Gordon and others (1968). Aliquots of the sample weighing approximately one gram are irradiated along with multi-element standards. Gamma-ray spectra are measured using both large volume Ge(Li) crystals and low energy photon detectors at four appropriate periods ranging from a few hours to 60 days after irradiation. Comprehensive data reduction programs are used to correct for differences in data acquisition parameters and for interelement interferences. Standardization and data quality are monitored by analyzing at least one USGS standard reference sample per analysis set. As mentioned previously, a summary of quality control data for the runs that generated the Survey INAA and ICP data presented in Appendix I of this paper are included here as Appendices II and III.

Methodology

Traditionally, numerical documentation of analytical error has utilized analysis of variance (ANOVA), but that procedure is not used here. As pointed out by Thompson (1983), ANOVA implicitly assumes that both sampling error and analytical error are constant over the entire range of concentrations under consideration, and this is rarely the case. Additionally, ANOVA must assume that the sample population comprises a normal distribution and, for the Ranger samples, this is intentionally not the case. Our samples were originally collected to yield the most geologic information about the ore bodies and therefore the suite of samples analyzed includes a disproportionate number of geologically "interesting" samples that we know are atypical. Conversely, some voluminous rock types (e.g. the dolomite and magnesite marbles) are purposely under-represented because we did not wish to spend our finite analytical budget on samples from which we expected to learn little. Because some of the duplicate samples were picked to answer what we felt were possible specific analytical problems, (e.g. interelement interferences due to very high uranium abundances), neither the original sample suite nor the set of

[1] Use of trade names in this report is for descriptive purposes only and does not constitute endorsement by the U.S. Geological Survey.

duplicates represent a normal distribution for many elements.

Additionally, it should be noted that ANOVA alone will not detect all deviations in precision and accuracy for different sets of data. For example, consider figure 1, a graph showing all five sets of aluminum analyses plotted against aluminum abundance as determined by XRF (the same relationships can be observed no matter which analytical method we plot the analyses against). The figure clearly shows that all five sets of analyses are comparable at low concentrations but that two of them (sets 2 and 4) diverge greatly from the other three for samples in which the aluminum concentration is above approximately five percent. ANOVA, however, indicates that these five data sets are not significantly different at the 99 percent confidence level. This lack of discrimination by ANOVA is no doubt partly because the differences in the divergent data are both positive and negative and thus tend to cancel each other (that is, the means of the five sets of data quite similar) and also because the data, when plotted as a histogram, do not form a normal distribution. The lack of a significant, systematic difference between data sets 2 and 4 as compared to the other three (as determined by ANOVA) plus the scatter in the data points probably means that the precision of the analyses is very poor, but that the accuracy of all five sets may be comparable. ANOVA alone, however, would not have detected this difference.

Instead of ANOVA, then, we calculated average deviations (in percent of the amount present) from either the average value (or, strictly, the arithmetic mean) or from what is termed here the "select value." Represented as a mathematical expression, the deviations were calculated as:

$$d = \frac{|\bar{x} - x_i|}{\bar{x}} \times 100 .$$

Where d is the deviation, $\bar{x}$ is the average abundance of the element in any particular sample, (the arithmetic mean of the abundance as determined by all methods for which that element is reported) and x_i is the i'th measurement of the abundance of the element in the sample. For calculating the deviation from the select value, x_s, the abundance of the element as determined by the selected method would be substituted for $\bar{x}$. The means of these deviations are the numbers shown in tables 1 and 2.

The "select value" was picked pragmatically but guided by our experiences with other research projects and the experiences of co-workers. All analyses were compared to either XRF values or to Geological Survey INAA values where those data were available. If neither XRF nor Survey INAA data were reported for any particular element, each value was compared to the average value reported for that sample by all methods. The only exceptions are uranium and thorium where values by other methods were compared to both the Survey INAA numbers and to the delayed neutron analyses.

As a partial justification for comparing most major elements to the XRF numbers, note table 3. When uranium, sulfur, carbon, and recalculated loss on ignition (LOI) are added to the XRF major element determinations, totals are all very nearly 100 percent. For the 50 samples, totals for the XRF major elements average 99.78 percent, indicating that these analyses are complete and suggesting that they are also acceptably accurate and precise.

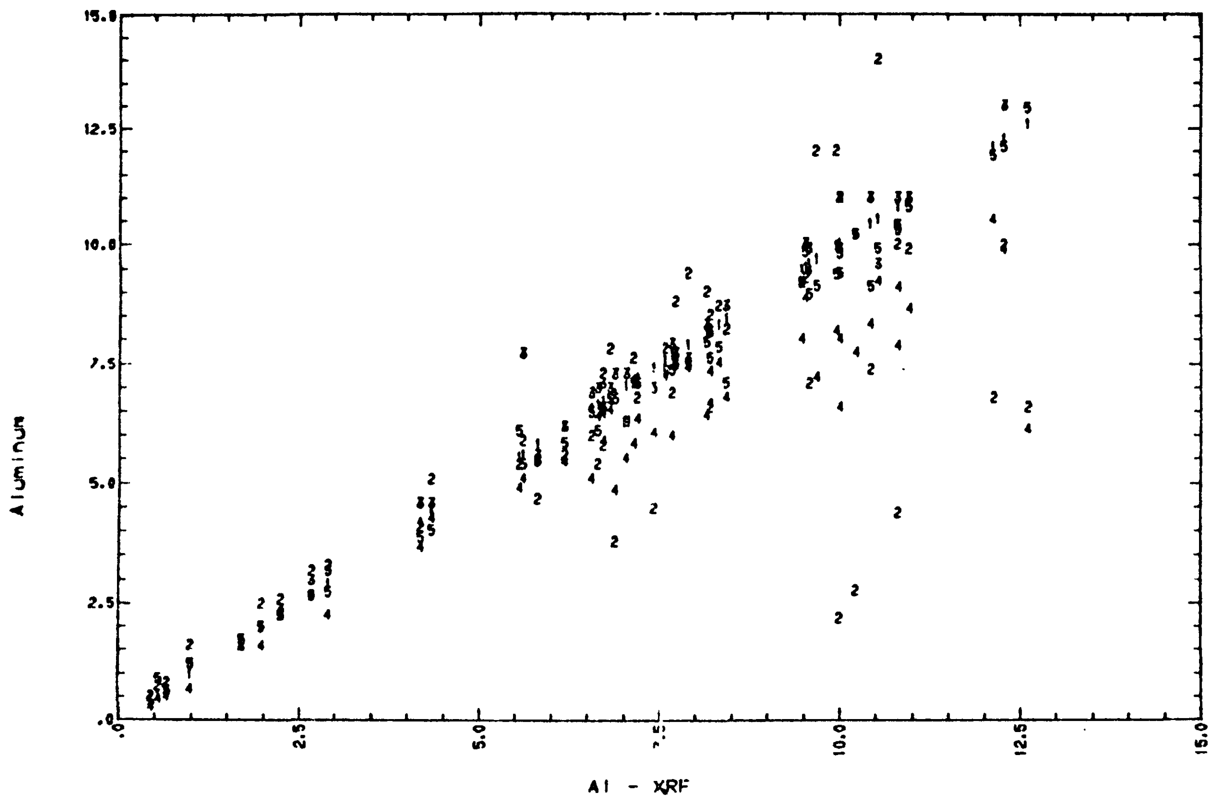

Figure 1. Aluminum abundance as determined by all analytical methods plotted against the values obtained by X-ray fluorescence. Plotting symbols are: 1 = XRF, 2, 3, & 4 = ICP, 5 = INAA.

Table 1: Average deviations and correlation coefficients for all elements calculated against the average for all analyses (*) or against the select value (**). The select value is marked in the column of the technique used. The number of pairs from which the correlation coefficient is calculated is shown in parentheses if less than twenty. "- -" indicates no matching pairs, "n r" means not reported. The column marked "Range" lists the range of values over which the deviations and correlations were determined, the range given being that for either the select value or the average, as appropriate. All "Range" values are in ppm except for Mg, Al, K, Ca, and Fe which are in percent.

Element / Analytical method	XRF	GS ICP1	GS ICP2	OR ICP	OR INAA	GS INAA	GS DN	Range
Li*	n r	25.1	10.0	20.7	n r	n r	n r	14 - 473
		.9971	.9946	.9941				
Be*	n r	9.7	8.6	10.5	n r	n r	n r	1 - 26.3
		.9941	.9962	.9937				
Na	26.1	35.1	318.4	23.1	26.8	**	n r	104 - 21,100
	.9970 (7)	.9908	.0112	.9982 (13)	.9764			
Mg	**	18.5	9.1	34.6	16.0	n r	n r	0.43 - 23.04
		.8639	.9794	.6770	.8942			
Al	**	20.5	6.3	16.1	5.9	n r	n r	0.44 - 12.60
		.7328	.9884	.9473	.9946			
P	**	30.4	16.9	25.0	n r	n r	n r	87 - 57,300
		.9949	.9997	.9798				
K	20.9	25.7	28.0	44.3	10.2	**	n r	0.039 - 5.41
	.9942	.9523	.9308 (17)	.9768	.9903			
Ca	**	49.2	71.1	16.1	7.5	n r	n r	0.01 - 20.15
		.9820	.9994	.9967	.9986			
Sc	n r	24.2	8.3	30.2	13.6	**	n r	0.65 - 70
		.5673	.9941	.9722	.9196			
Ti	**	43.9	24.8	44.6	103.2	n r	n r	60 - 7250
		.9585	.9519	.8559	.8981			
V *	n r	18.5	15.7	21.7	39.4	n r	n r	4.5 - 524
		.8590	.9269	.9224	.8908			
Cr	n r	16.6	39.5	17.9	27.6	**	n r	0.7 - 520
		.9768	.9895	.9973	.9326			
Mn	24.4	40.5	22.6	20.9	7.2	**	n r	21 - 2370
	.9913 (16)	.9750	.9908	.9939	.9970			

Table 1 (continued)

Element / Analytical method	XRF	GS ICP1	GS ICP2	OR ICP	OR INAA	GS INAA	GS DN	Range
Fe	3.5	18.9	5.7	8.7	17.0	**	n r	0.40 - 25.6
	.9984	.9759	.9975	.9967	.9612			
Co	n r	22.0	18.6	10.1	19.7	**	n r	1.6 - 79.3
		.9862	.9840	.9934	.9417			
Ni*	n r	21.9	8.8	21.5	n r	n r	n r	4.5 - 445
		.9957	.9876	.9952				
Cu*	n r	31.9	18.2	30.1	10.8	n r	n r	3.5 - 19,720
		.9998	.9994	.9999	.9995 (5)			
Zn*	n r	18.1	17.5	16.8	68.3	n r	n r	2 - 274
		.9086	.8351	.8907	.9098 (7)			
Ga*	n r	15.8	14.3	n r	16.6	n r	n r	4.5 - 91.5
		.9510	.9335		.9135			
As*	n r	12.9	15.8	n r	11.2	n r	n r	1 - 60
		.9734 (15)	.9664 (5)		.9925 (11)			
Rb	n r	n r	n r	n r	50.9	**	n r	2.6 - 240
					.9716			
Sr*	n r	23.6	11.7	21.9	n r	47.2	n r	2.5 - 310
		.9799	.8481	.9822		.8533 (4)		
Y *	n r	10.2	14.5	15.9	n r	n r	n r	1 - 260
		.9989	.9992	.9967				
Zr	n r	n r	n r	n r	1449.3	**	n r	3.4 - 700
					-.2032 (7)			
Nb*	n r	21.8	18.6	21.5	n r	n r	n r	4 - 23.3
		.9590	.8903 (18)	.8615				
Cs	n r	n r	n r	n r	18.9	**	n r	0.034 - 17.4
					.9914			
Ba	n r	60.7	71.9	54.7	157.4	**	n r	35.7 - 31,000
		.0809	.1209	.0770	.9052			
La	n r	48.0	51.7	39.5	76.5	**	n r	0.40 - 495
		.7833	-.0017	.7821	.9416			
Ce	n r	42.6	45.2	65.9	39.1	**	n r	0.23 - 663
		.9589	.7794 (14)	.9827	.9522			

Table 1 (continued)

Element	Analytical method XRF	GS ICP1	GS ICP2	OR ICP	OR INAA	GS INAA	GS DN	Range
Nd	n r	38.5 .8114	36.4 .7171 (16)	n r	8.0 - -	**	n r	0.4 - 170
Sm	n r	19.7 .9633 (9)	n r	n r	60.9 .8077	**	n r	0.3 - 62.8
Eu	n r	11.2 .9956 (13)	8.6 .9985 (12)	n r	124.2 .9481	**	n r	0.06 - 30.1
Gd	n r	31.3 .9211 (7)	18.6 .9967 (5)	n r	81866.0 .7777 (7)	**	n r	0.4 - 109
Tb	n r	1077.0 .8714 (9)	5374.0 -.0223	n r	32.4 .9621 (19)	**	n r	0.06 - 20.2
Dy	n r	173.7 .9820	40.8 .9924	n r	72.7 .9519 (6)	**	n r	0.37 - 111
Ho*	n r	11.1 - -	8.9 - -	n r	n r	n r	n r	0.3 - 17.5
Er*	n r	16.0 - -	12.4 - -	n r	107.7 - -	n r	n r	4 - 36.5
Tm	n r	n r	n r	n r	260.6 1.0000 (2)	**	n r	0.03 - 6.9
Yb	n r	20.7 .9923	11.9 .9977	n r	35.0 .9426	**	n r	0.13 - 29.9
Ta	n r	n r	n r	n r	30.4 .9050	**	n r	0.03 - 9.26
Pb*	n r	10.5 .9987	16.0 .9985	12.7 .9987	n r	n r	n r	4 - 7664
Th	n r	103.5 .6539	14.4 .9844	195.6 .3380	13.7 .9769	**	37.5 .9899	0.55 - 79.6
Th	n r	33.0 .9776 (11)	22.1 .9933 (5)	46.4 .9507 (12)	22.9 .9902 (12)	21.7 .9899 (13)	**	4.5 - 88.7
U	n r	79.7 .9939	41.2 .9935 (18)	n r	24.8 .9935	**	34.2 .9987	1.01 - 25,900
U	n r	33.3 .9976	7.7 .9974 (1[illegible])	n r	15.1 .9932	25.1 .9987	**	1.4 - 36,900

Table 2: Correrlation coefficients and average deviations for elements listed in Nash and Frishman (1983). Correlation coefficients and average deviations are calculated against the average value (*), XRF value (x), delayed neutron value (D), or the INAA value (unmarked). Symbols for elements are the same as those used in Nash and Frishman (1983). No data for Si, Al, Fe, Mg, Ca, K, Au, B, Br, Cl, F, Ir, Mo, Pr, or W.

Element	correlation coefficient	no. of pairs	Deviation in per cent
T-Fe203	0.9984	50	3.5
U N D	0.9932	50	15.1
As N *	0.9925	11	11.2
Ba	0.0770	41	54.7
Ba N	0.9052	21	157.4
Be *	0.9937	49	10.5
Ce	0.2392	26	69.2
Ce N	0.9522	28	39.1
Co	0.9934	47	10.1
Co N	0.9417	47	19.7
Cr	0.9973	45	17.9
Cr N	0.9326	44	27.6
Cs N	0.9914	29	18.9
Cu *	0.9999	49	30.1
Dy N	0.9519	6	72.7
Eu N	0.9481	42	124.2
Ga N *	0.9135	25	16.6
Gd N	0.7777	7	81866
La	0.7821	29	39.5
La N	0.9416	47	76.5
Li *	0.9941	50	20.7
Mn	0.9939	49	20.9
Mn N	0.9970	49	7.2
Na N	0.9764	39	26.8

Element	correlation coefficient	no. of pairs	Deviation in per cent
Nb *	0.8615	32	21.5
Nd N	-	1	8.0
Ni *	0.9952	49	21.5
P	0.9798	48	25.0
Pb *	0.9987	36	12.7
Rb N	0.9716	24	50.9
Sc	0.9722	49	30.2
Sc N	0.9196	47	13.6
Sm N	0.8077	35	60.9
Sr *	0.9822	50	21.9
Ta N	0.9050	20	30.4
Tb N	0.9621	19	32.4
Th	0.3380	40	195.6
Th N	0.9769	45	13.7
TiO2 *	0.9857	50	-
Ti x	0.9123	50	44.6
Tm N	1.0000	2	260.6
V *	0.9244	49	21.7
V N *	0.8908	44	39.4
Y *	0.9967	49	15.9
Yb N	0.9426	29	35.0
Zn *	0.8907	49	16.8
Zr N	-0.2032	7	1449

Table 3: Whole rock, major element analyses for 50 samples from the Ranger Orebodies, Northern Territory, Australia.

Sample / Element	19 268.5	19 327.8	19 337C	29 17.3	30 343.5	30 348.5	32 47.5	33 27.7	33 123.7	38 51.5
SiO2	66.20	17.60	5.93	80.50	44.10	86.90	26.70	57.00	72.20	69.10
Al2O3	15.70	5.50	.84	4.25	20.40	1.24	20.70	18.90	14.90	12.90
T-Fe2O3	4.41	2.09	.50	2.93	9.27	4.72	13.40	6.35	1.60	3.02
MgO	2.13	17.80	20.80	4.53	9.04	.87	19.10	8.55	1.69	4.80
CaO	3.72	21.20	28.20	2.70	.25	.04	5.44	.07	.18	.06
Na2O	2.84	>.15	>.15	>.15	>.15	>.15	>.15	.16	>.15	>.15
K2O	3.72	1.32	.14	.01	4.25	.01	.14	2.99	6.44	2.35
TiO2	.51	.16	.01	.10	.97	.01	.67	.86	.01	.41
P2O5	.12	.02	.02	2.03	.18	.02	4.07	.07	.17	.05
MnO	.05	.13	.05	>.02	>.02	>.02	.03	>.02	>.02	>.02
T-C	n. a.	8.68	n. a.	n. a.	3.23	.22	.14	n. a.	n. a.	n. a.
T-S	n. a.	>.01	n. a.	n. a.	1.58	3.46	>.01	n. a.	n. a.	n. a.
U	.00	.00	.00	.00	.00	.03	.00	.00	.00	.35
LOI	.93	25.22	42.90	2.55	6.03	.58	10.06	5.60	2.39	5.31
Total	100.33	99.88	99.54	99.77	101.47	100.07	100.61	100.57	99.75	98.52

Sample / Element	38 163C	38 193.8	55 138.2	55 194.9	56 22C	59 64.8	61 258C	64 103.0	64 138.0	64 151.4
SiO2	31.90	31.00	49.40	51.80	58.10	32.20	53.80	89.80	3.56	59.40
Al2O3	1.02	19.30	17.90	19.70	13.30	22.90	14.00	3.22	1.85	19.90
T-Fe2O3	1.74	10.40	2.64	3.22	9.73	11.00	3.52	1.81	2.90	3.19
MgO	33.10	26.30	6.81	14.90	10.60	19.70	17.50	3.53	26.30	7.37
CaO	.85	.13	7.10	.20	.12	.01	.99	.06	21.20	.05
Na2O	>.15	>.15	>.15	>.15	>.15	>.15	>.15	>.15	>.15	>.15
K2O	.03	.01	3.94	.01	.69	1.86	.03	.01	.01	3.92
TiO2	.03	.67	.91	.01	.35	1.21	.31	.02	.06	.91
P2O5	.06	.10	5.21	.13	.13	.19	.37	.02	.06	.02
MnO	.12	>.02	>.02	>.02	>.02	>.02	>.02	>.02	.34	>.02
T-C	n. a.	n. a.	n. a.	.06	n. a.	n. a.	n. a.	n. a.	n. a.	n. a.
T-S	n. a.	n. a.	n. a.	>.01	n. a.	n. a.	n. a.	n. a.	n. a.	n. a.
U	.00	.00	.01	.00	.12	.00	.00	.00	.00	.00
LOI	30.30	11.70	5.43	8.20	6.77	10.20	8.40	1.81	43.80	5.36
Total	99.30	99.78	99.52	98.41	100.08	99.44	99.09	100.45	100.23	100.29

	64 194.0	65 92.8	70 15.3	70 26.4	70 28.5	70 112.0	70 113.0	70 143.0	70 166.1	73 44.1
SiO2	54.10	52.64	66.10	62.30	60.70	59.60	62.40	30.40	29.00	12.03
Al2O3	13.00	12.55	10.50	12.70	15.90	14.50	11.70	23.80	20.40	7.91
T-Fe2O3	7.53	6.24	4.62	5.20	3.99	8.26	7.49	12.50	10.60	34.83
MgO	17.20	12.18	9.09	9.52	9.73	10.20	9.69	21.30	22.50	9.45
CaO	.43	.35	1.00	.23	.13	.32	.40	.49	.57	17.53
Na2O	>.15	>.15	>.15	>.15	>.15	>.15	>.15	>.15	>.15	>.15
K2O	.01	.07	.06	.31	.29	.45	.07	.04	.02	.01
TiO2	.11	.23	.28	.28	.47	.01	.01	.01	.53	.21
P2O5	.29	.16	.84	.21	.13	.24	.30	.36	.39	13.12
MnO	>.02	.07	>.02	>.02	>.02	>.02	>.02	>.02	.02	.02
T-C	.03	n. a.	n. a.	n. a.	.03	n. a.	n. a.	n. a.	n. a.	.16
T-S	.12	n. a.	n. a.	n. a.	.07	n. a.	n. a.	n. a.	n. a.	>.01
U	.19	3.61	.22	.54	.20	.03	.61	.00	1.22	.01
LOI	7.83	7.84	7.01	7.92	7.36	6.17	5.61	11.90	12.80	4.62
Total	101.01	100.59	99.89	99.38	99.17	99.95	98.45	100.97	98.20	100.06

	73 47.6	73 103C	73 178.3	78 145C	79 106.0	79 234.9	80 36C	80 47.6	80 54C	80 68.2
SiO2	63.50	37.30	68.40	58.60	44.90	33.50	62.20	70.10	68.50	73.00
Al2O3	15.50	23.20	14.60	18.30	18.10	18.90	12.40	8.21	12.70	10.60
T-Fe2O3	4.03	9.29	3.22	4.80	8.88	5.27	4.53	2.97	3.72	3.56
MgO	7.40	15.80	3.75	7.38	14.80	26.40	11.10	7.62	7.51	6.72
CaO	.27	.24	.38	.06	.18	1.41	.07	.09	.13	.07
Na2O	>.15	.18	>.15	.28	>.15	>.15	>.15	>.15	>.15	>.15
K2O	3.01	3.05	4.85	3.39	.41	.86	.52	.86	1.76	.93
TiO2	.99	1.12	.57	.80	.62	.01	.33	.21	.39	.20
P2O5	.24	.05	.31	.05	.14	1.00	.06	.07	.08	.06
MnO	>.02	>.02	.03	>.02	>.02	>.02	>.02	.03	>.02	>.02
T-C	n. a.	n. a.	n. a.	n. a.	.16	.17	n. a.	n. a.	n. a.	.20
T-S	n. a.	n. a.	n. a.	n. a.	.12	.18	n. a.	n. a.	n. a.	.01
U	.00	.17	.00	.47	1.61	.00	.42	2.43	.09	.17
LOI	4.96	9.32	3.57	5.24	9.61	11.62	7.00	5.65	5.10	5.06
Total	100.07	99.74	99.83	99.38	99.40	99.49	98.80	98.39	100.15	100.75

	80 178C	81 72.4	83 158.6	83 294.9	83 516.8	97 67.1	97 86.6	97 90.2	PM 172.2	PM 221.9
SiO2	12.60	60.40	58.40	59.00	34.90	55.30	65.20	36.70	72.60	59.40
Al2O3	3.72	15.40	15.50	11.00	13.50	5.05	14.30	18.00	13.60	18.80
T-Fe2O3	3.45	7.67	6.67	4.15	2.42	2.10	2.89	7.26	2.32	4.09
MgO	38.20	7.12	11.80	12.70	24.50	6.98	8.27	15.10	.72	5.35
CaO	1.72	.14	.33	.62	6.89	15.40	.01	6.15	.70	.83
Na2O	>.15	>.15	>.15	.16	.20	>.15	>.15	>.15	1.98	>.15
K2O	.03	2.72	.72	.08	1.60	.01	2.52	1.33	6.24	4.49
TiO2	.12	.59	.01	.33	.49	.26	.52	.86	.22	.64
P2O5	.06	.11	.24	.10	.02	11.50	.10	4.49	.06	.30
MnO	.24	.05	.02	>.02	>.02	>.02	>.02	>.02	.02	.08
T-C	n. a.	n. a.	n. a.	n. a.	n. a.	n. a.	n. a.	n. a.	n. a.	n. a.
T-S	n. a.	n. a.	n. a.	n. a.	n. a.	n. a.	n. a.	n. a.	n. a.	n. a.
U	.00	.00	.00	1.57	.00	.00	.00	.24	.00	.00
LOI	40.10	5.99	6.19	7.52	14.80	3.19	5.48	9.35	1.12	5.04
Total	100.39	100.34	100.03	99.95	99.34	99.96	99.46	99.65	99.58	99.17

Notes

For samples having sulfur, carbon, or iron as a major constituent, LOI has been recalculated to account for loss of carbon, loss of sulfide sulfur with an approximation for the concommittent gain of oxygen (e.g. FeS2 is transformed to Fe2O3) and oxygen gain because all iron is converted to ferric. Totals listed include all constituents with abundances greater than one percent except those shown to be erroneous determinations (see text for discussion).

"T-Fe2O3" = total iron expressed as Fe2O3, "T-C" and "T-S" = total carbon and total sulfur, respectively.

"n. a." = no analysis.

Total listed for sample 30-348.5 includes 1.8 percent Copper, and totals for samples 65-92.8 and 83-294.9 include 4.5 and 2.7 percent barium, respectively, but see text for discussion of Ba analyses.

Sample ID's indicate drillhole number and depth in meters abbreviated as in Nash and Frishman (1983).

All analyses in per cent.

All analyses by X-ray fluorescence spectroscopy except carbon and sulfur (by LECO carbon and sulfur determinators, respectively), uranium (by instrumental neutron activation analysis) and LOI (= loss on ignition) by weight loss when fired at 900 C.

X-ray fluorescence analyses and LOI by J. S. Wahlberg, J. E. Taggart, and J. W. Baker.

Sulfur and carbon analyses by J. Ryder.

Uranium analyses by Nuclear Division, Oak Ridge National Laboratory.

The deviations described above were calculated for each of the 50 samples for each analytical method and then the mean deviation for each element by each method was calculated. This method also suffers from an oversimplification because total error is no doubt a function of concentration in some cases, but our goal here is to assess the impact of analytical error on the geochemical insights gained from the statistical manipulations presented in Nash and Frishman (1983) and our simplifying assumption should not detract from that end.

Discussion - Interelement Correlations

Uranium and Thorium

Nash and Frishman (1983, p. 14) noted that thorium and uranium abundances were well correlated by ICP, but not by INAA. The ICP values do not compare well to the Survey INAA numbers (correlation coefficient of 0.34, average percent deviation of 195.6, table 2) and the numbers that disagree most widely (the "fliers") are all from samples that have a high uranium content. The Oak Ridge INAA, on the other hand, agrees very well with the Survey INAA and the DN values (correlations of 0.9769 and 0.9899, respectively, table 1) and thus the "Th N" values reported in Nash and Frishman (1983) are the more correct determinations. As noted before, the "U N" and "Th" values reported previously did not correlate well, and therefore we now feel that the postulated U-Th correlation at Ranger does not exist.

Uranium and Rare Earth Elements (REE)

Nash and Frishman (1983) refer to a possible U-REE correlation at Ranger, and other investigators have also suggested that such an association may exist in the uranium deposits of the Pine Creek Geosyncline. McLennan and Taylor (1980) used spark-source mass spectrometry as an analytical tool on five mineralized samples from the Cahill Formation, one of which was from Ranger, and concluded that there was indeed a correlation between uranium and the REE. Ferguson and others, (1980) quoted unpublished data by G. A. Cowan as confirming an HREE-U correlation, and more recently published but fragmentary data suggest that a correlation may exist between U and Ce, but not La, at Nabarlek (Ewers and others, 1983) and between U and La in two mineralized schists from Jabiluka (Gustafson and Curtis, 1983).

It is obvious from table 1 that the Gd analyses listed in Nash and Frishman (1983) are worthless and that the Tb determinations by ICP are subject to very large errors (Gd deviations average nearly 82,000 percent, Tb determinations by ICP deviate by from 1000 to 5000 percent). We still wonder, however, if the overall correlation between U and the REE that appeared from our statistical manipulation of the entire 370 sample data set is real. To determine if a correlation between U and the REE exists, two questions must be answered; 1) are the values listed for the REE in Nash and Frishman (1983) usable INAA values (close to what the values should be as determined by instrumental neutron activation) and 2) are these values close to the true abundance of the element in the rock or are they the result of unavoidable interferences caused by the high uranium content of these ores?

The first question can be answered in part by comparing the Oak Ridge and the Geological Survey INAA results. Correlation coefficients for all of the

REE for which we have two sets of INAA data are listed in table 2 and reproduced below with the number of pairs of analyses for which the coefficient is calculated in parentheses.

La	0.9416	(47)
Ce	0.9522	(28)
Sm	0.8077	(35)
Eu	0.9481	(42)
Gd	0.7777	(7)
Tb	0.9621	(19)
Dy	0.9519	(6)
Tm	1.0000	(2)
Yb	0.9426	(29)

With the exception of Tm (only two data points) these coefficients don't look very good. If one were looking for interelement correlations in a large data set, they would be most impressive, but when comparing analyses of sample splits analyzed by the same technique by different laboratories, the results seem rather feeble. In order to better visualize what these correlation coefficients mean, we have reproduced scatter diagrams for La, Sm, Eu, and Yb as figure 2. This figure shows that the general trend of the values is the same in both data sets although the reproducibility between sets is generally poor. We do not feel that the Oak Ridge data are accurate enough to make chondrite-normalized rare-earth plots a worthwhile endeavor. Duplicate analyses of samples for which high concentrations are reported by one determination are in general also high by the second determination, and the low numbers in one set are correspondingly low in the other. It seems that the values reported in Nash and Frishman (1983) are probably reasonable representations of the INAA rare-earth abundances (with the exception of Gd).

To answer the second question - is the INAA technique subject to large unrecognized interelement interferences for these uranium ores - we can look at the REE abundances as determined by both INAA and ICP. As shown in table 1, the results obtained by these two techniques for the REE are similar. Correlations and deviations between ICP and INAA are in general good for Sm, Eu, Gd, Dy, and Yb, fair for many of the La, Ce, and Nd analyses, and poor only for Tb (the remaining REE are either not reported or there are not enough data for a meaningful comparison). This indicates that the high uranium abundances probably do not interfere with the rare earth determinations, and consequently that the correlations alluded to in Nash and Frishman (1983) are real and are not the result of spurious analyses.

Barium

The barium analyses in Appendix I present a vexing problem, one that is as yet unresolved. There are five sets of data for Ba, three sets by ICP two by INAA. The three ICP sets compare well to each other, and the same is true for the two INAA data sets, but the ICP and INAA methods yield vastly different results. The INAA values are consistently much higher than the ICP, especially for samples with high uranium abundances. Inspection of the barium and uranium data in Appendix I shows that every sample for which more than 10,000 ppm (or one percent) uranium is reported also has more than 10,000 ppm barium by either INAA determination, whereas the ICP barium numbers reported for the same samples are typically two orders of magnitude lower. Obviously

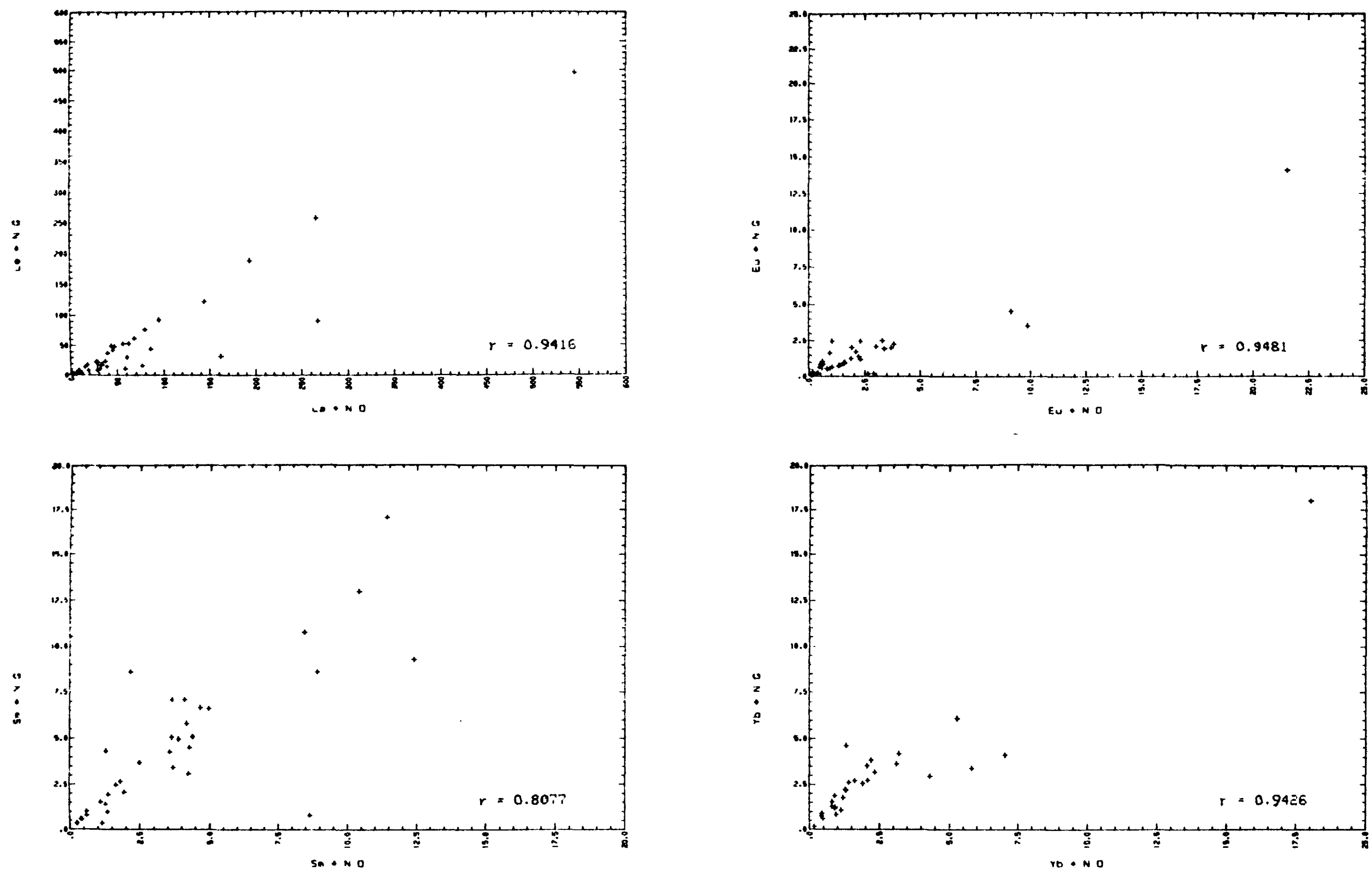

Figure 2. Scatter diagrams showing the correlation between Oak Ridge and Geological Survey INAA analyses for La, Eu, Sm, and Yb. Labels on axes are the same as those used in Appendix I. r = correlation coefficient. Note that the correlation coefficients for La, Eu, and Yb (and for some of the other REE's) are higher than they would be if the solitary, inordinantly high points were not present (correlation coefficients are quite sensitive to anomalous values like these). For these three elements, coefficients fall to 0.8590, 0.8280, and 0.7438, respectively, if the high values are excluded.

there is either a very strong correlation between U and Ba (with the ICP numbers being in error) or an unrecognized INAA analytical interference is generating spurious results. However, some samples (like 19-268.5 or PM-172.2) contain relatively low U but high Ba (high by both INAA and ICP) suggesting that at least some rocks have been enriched in the barium.

The problem is compounded because there is reason to believe that the ICP results may also be in error. When the powdered sample is dissolved prior to ICP analysis, barium present in solution would probably precipitate as a barium sulfate (barite) if sulfur were also present when the sample was evaporated to dryness. Once precipitated, this barite would not completely dissolve in the aqua regia and nitric acid used to redissolve and dilute the sample and thus would not be detected when the sample was finally aspirated and the elemental abundances were determined. We have tried to test this latter possibility by looking at both Ba and S abundances in the samples (the technique by which S was determined is not affected by this dissolution problem) but the results were inconclusive, largely because we do not have sufficient sulfur data. There are numerous procedures that could be applied to these samples to resolve this problem, but at this point all we can say is that we have two different sets of data, both are internally consistent, and we don't know which is correct.

Other Elements

Because of our uncertainties, Nash and Frishman (1983) list both the INAA and the ICP analyses for a number of elements. For those elements that were reported twice, we feel that the INAA (the "N" analyses in Appendix I of Nash and Frishman, 1983) data are more correct for Ce, La, Mn, Sc, Th, and Zr, whereas the ICP data set is better for Co, Cr, and V. Note, however, that none of the La or Sc analyses are very good and that both sets of titanium data are usable. Titanium by XRF appears to be more accurate at high concentrations, but Ti by ICP agrees fairly well with the XRF where the two sets of data overlap and the ICP method has a much lower limit of detection.

The gadolinium analyses reported in our previous paper are probably meaningless. Correlation with the Survey INAA analyses is poor and the average error is stupendous. We suspect that some of the values reported as unqualified values (i.e. reported as real data instead of as a "less than" value) should in fact have been qualified and that the qualifier was lost somewhere in the data transmission, but this presumption does not allow us to "save" the gadolinium data set and we feel that it is best ignored.

The boron analyses (by ICP) listed in Nash and Frishman (1983) should also be ignored. When digested in hydrofluoric acid, much of the boron present in the sample is volatilized as a boron fluoride (Crock, and others, 1983) and hence the numbers reported probably have little or no meaning.

We have only two sets of INAA analyses for zirconium, and, as shown in table 2, the two do not agree. Not only is the average deviation between the seven samples for which we have both sets of data very high, but the correlation coefficient is actually negative. In part, these differences may be due to what is sometimes called the "nugget effect." Almost all of the zirconium resides in zircons. When an element is concentrated in a single mineral, accurate splitting of the sample powders, even when ground to minus

100-mesh, is very difficult and increases the chance of a "nugget" of zircon being included in one aliquot of sample and not in another. At this point, we only know that the two sets of analyses are different and that one or the other or both may be correct, but the data available do not allow us to choose between them.

An additional consideration when dealing with uranium ores is that a very large numerical correction is required to determine zirconium abundance in uranium-rich samples by INAA. Because of the magnitude of this correction, an analysis should be considered suspect if the corrected zirconium abundance is not greater than the uranium.

A number of other points illustrated in table 1 require explanation. The very large disagreement between the GS ICP2 determination for Na and all the other methods (318 percent) arises from a single sample (0.0277 percent by INAA, 2.6 percent by ICP2). If that sample is discarded, average deviation falls to 19.5 percent and the correlation coefficient increases correspondingly. (It is worth noting here that the ICP2 data for the deviant sample, sample 80-68.2, shows very large apparent errors for many elements, although Na is the worst case, and we suspect that the split used for the ICP2 analyses may have been contaminated or mislabeled). The very low correlation for La by the same method, however, results from five samples which differ significantly from the other determinations and must be due to a systematic error which we have not been able to identify. Both ICP determinations for Tb seem to be in error and, because they agree neither with the INAA numbers nor with each other, they are probably best ignored.

Summary and Conclusions

For the reasons discussed above, analyses listed in Nash and Frishman (1983) for B, Gd, and Th (by ICP) have no meaning and should be ignored. Consequently, the postulated correlation between uranium and thorium to which Nash and Frishman alluded is also illusory. For those elements that were listed twice in our previous report, the ICP analyses are considered superior for Co, Cr, and V whereas the INAA analyses are the better determinations for Ce, La, Mn, Sc, Th, and Zr, although great care is required when interpreting results for Zr in uranium-rich samples.

Although the precision of the REE analyses reported in our previous paper is not high, the analyses are sufficiently good to indicate the general trend of REE abundances, and the REE-uranium correlation we reported earlier is probably real.

The deviations of the ICP analyses reported in Nash and Frishman (1983) from either the average analysis or our preferred analysis range from 8.7 to 195 percent of the amount present, and the range for the INAA analyses is similar (5.9 to 157 percent). Most deviations, however, are between 20 and 35 percent and many of the analyses are of sufficiently good quality to allow some chemical distinctions between different types of ore and different types of alteration to be made.

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Appendix I
Replicate Analyses for Fifty Whole-rock
Samples from the Ranger Uranium Mine

(See "Notes" at the end of this Appendix for an explanation of the abbreviations used in column headings and elsewhere.)

Ranger Uranium Mine Duplicate Analyses

SAMPLE	Al% X G	Al% I1 G	Al% I2 G	Al% I O	Al% N O	Fe% X G	Fe% I1 G	Fe% I2 G	Fe% I O	Fe% N O
19 268.5	8.31	8.70	.00B	7.52	7.84	3.08	3.00	.00B	2.87	2.97
19 327.8	2.91	3.30	3.20	2.24	2.75	1.46	1.80	1.50	1.31	1.56
19 337C	.44	.53	.00B	.26	.40	.35	.51	.00B	.31	.42
29 17.3	2.25	2.60	2.40	2.35	2.24	2.05	2.20	2.10	2.13	2.52
30 343.5	10.80	10.00	11.00	7.89	10.40	6.48	7.90	6.40	5.85	7.27
30 348.5	.66	.82	.63	.50	.65	3.30	3.40	3.40	2.90	3.61
32 47.5	10.96	9.90	11.00	8.65	10.80	9.37	11.00	9.20	8.44	9.22
33 27.7	10.00	11.00	9.90	8.00	9.80	4.44	5.60	4.30	3.84	4.35
33 123.7	7.89	9.40	7.60	7.41	7.49	1.12	1.40	1.10	1.11	1.09
38 51.5	6.83	7.80	7.00	6.54	6.77	2.11	2.50	2.20	2.07	2.36
38 163C	.54	.75	.00B	.45	.88	1.22	.92	.00B	1.09	1.84
38 193.8	10.21	2.80	.00B	7.73	10.20	7.27	7.00	.00B	6.64	8.54
55 138.2	9.47	9.20	.00B	8.00	9.20	1.85	2.20	.00B	1.66	2.19
55 194.9	10.43	7.40	11.00	8.32	9.13	2.25	2.90	2.20	1.84	2.37
56 22C	7.04	6.30	7.30	5.53	6.30	6.81	7.00	6.90	5.83	7.85
59 64.8	12.12	6.80	.00B	10.52	11.90	7.69	9.00	.00B	7.23	8.56
61 258C	7.41	4.50	.00B	6.06	7.00	2.46	2.70	.00B	2.22	2.87
64 103.0	1.70	1.60	.00B	1.59	1.73	1.27	1.30	.00B	1.25	1.52
64 138.0	.98	1.60	1.20	.67	1.22	2.03	2.30	2.00	1.34	1.94
64 151.4	10.53	14.00	9.60	9.22	9.91	2.23	4.00	2.00	1.92	2.50
64 194.0	6.88	3.80	7.30	4.87	6.76	5.27	5.30	5.30	4.83	5.45
65 92.8	6.64	5.40	7.00	6.40	6.10	4.36	5.20	5.00	4.66	.00B
70 15.3	5.56	5.40	.00B	4.92	6.10	3.23	3.20	.00B	3.21	3.40
70 26.4	6.72	5.80	7.10	6.46	6.60	3.64	4.20	3.80	3.60	3.99
70 28.5	8.41	8.20	8.70	6.80	7.09	2.79	3.10	2.80	2.48	1.85
70 112.0	7.67	6.90	7.90	6.01	7.37	5.78	6.40	5.80	5.07	6.35
70 113.0	6.19	5.60	6.20	5.45	5.86	5.24	5.60	5.30	5.04	1.69
70 143.0	12.60	6.60	.00B	6.14	12.94	8.74	9.60	.00B	7.30	9.70
70 166.1	10.80	4.40	11.00	9.10	10.30	7.41	8.50	7.70	7.32	.00B
73 44.1	4.19	4.10	4.60	3.69	3.87	24.36	23.00	24.00	23.77	49.70
73 47.6	8.20	8.50	.00B	7.33	8.15	2.82	4.20	.00B	2.67	2.52
73 103C	12.28	10.00	13.00	9.90	12.10	6.50	9.80	6.30	5.43	7.12
73 178.3	7.73	8.80	7.70	7.46	7.50	2.25	2.90	2.30	2.26	2.51
78 145C	9.69	12.00	.00B	7.22	9.12	3.36	5.20	.00B	3.17	3.93
79 106.0	9.58	7.10	9.90	9.43	8.94	6.21	7.30	6.40	6.06	9.02
79 234.9	10.00	2.20	11.00	6.61	9.39	3.69	3.90	3.70	2.96	4.72
80 36C	6.56	6.00	6.90	5.11	6.50	3.17	3.70	3.30	2.82	4.49
80 47.6	4.35	5.10	4.60	4.28	4.02	2.08	2.40	2.30	1.98	2.33
80 54C	6.72	7.30	.00B	5.89	6.57	2.60	2.80	.00B	2.32	2.74
80 68.2	5.61	5.90	7.70	5.12	5.40	2.49	2.50	2.10	2.40	2.55
80 178C	1.97	2.50	.00B	1.58	2.00	2.41	1.80	.00B	1.96	3.12
81 72.4	8.15	9.00	8.30	6.42	7.94	5.36	5.90	5.30	4.64	5.70
83 158.6	8.20	6.60	.00B	6.68	7.60	4.66	5.20	.00B	4.03	4.50
83 294.9	5.82	4.70	5.60	5.48	5.49	2.90	3.70	2.80	2.92	.00B
83 516.8	7.14	7.60	.00B	5.82	7.10	1.69	1.60	.00B	1.42	1.60
97 67.1	2.67	3.20	3.00	2.67	2.68	1.47	1.60	1.50	1.46	1.64
97 86.6	7.57	7.80	.00B	7.23	7.34	2.02	2.30	.00B	2.01	2.02
97 90.2	9.53	9.30	10.00	8.86	9.84	5.08	5.40	5.10	4.76	4.77
PM 172.2	7.20	6.80	.00B	6.34	7.08	1.62	1.50	.00B	1.53	1.55
PM 221.9	9.95	12.00	.00B	8.17	9.36	2.86	4.40	.00B	2.55	3.00

Ranger Uranium Mine Duplicate Analyses - continued

SAMPLE	Fe% N G	Mg% X G	Mg% I1 G	Mg% I2 G	Mg% I O	Mg% N O	Ca% X G	Ca% I1 G	Ca% I2 G	Ca% I O
19 268.5	3.06	1.28	1.30	.00B	1.08	1.13	2.66	2.50	.00B	2.01
19 327.8	1.48	10.73	12.00	10.00	6.66	10.77	15.15	17.00	15.00	12.06
19 337C	.40	12.54	14.00	.00B	4.10	12.70	20.15	29.00	.00B	16.50
29 17.3	2.05	2.73	3.10	2.80	2.49	2.58	1.93	2.00	2.00	1.85
30 343.5	6.63	5.45	5.60	5.20	3.82	5.00	.18	.24	.20	.14
30 348.5	3.15	.52	.68	.54	.40	.72	.03	.08	.05	.05L
32 47.5	8.99	11.52	11.00	10.00	5.86	11.30	3.89	4.10	3.80	2.87
33 27.7	4.40	5.16	6.20	4.90	3.53	4.90	.05	.08	.07	.06
33 123.7	1.15	1.02	1.20	.96	.92	.94	.13	.19	.16	.13
38 51.5	2.04	2.89	3.40	2.90	2.50	4.19	.04	.10	.07	.05
38 163C	1.20	19.96	12.00	.00B	3.98	20.20	.61	.59	.00B	.49
38 193.8	7.21	15.86	9.30	.00B	5.82	15.60	.09	.10	.00B	.08
55 138.2	1.85	4.11	3.90	.00B	3.19	3.80	5.07	4.70	.00B	3.78
55 194.9	1.92	8.99	6.30	8.40	5.85	7.92	.14	.20	.16	.10
56 22C	6.79	6.39	5.60	6.00	4.18	6.10	.09	.26	.10	.09
59 64.8	8.08	11.88	7.00	.00B	5.90	11.10	.01	.03	.00B	.05L
61 258C	2.43	10.55	8.00	.00B	5.87	10.00	.71	.78	.00B	.54
64 103.0	1.28	2.13	2.10	.00B	1.90	2.04	.04	.06	.00B	.05L
64 138.0	2.00	15.86	13.00	13.00	4.86	15.80	15.15	21.00	15.00	12.48
64 151.4	2.28	4.44	6.70	3.90	3.33	4.32	.04	.09	.06	.05L
64 194.0	5.13	10.37	7.20	9.30	6.11	.00B	.31	.32	.33	.21
65 92.8	4.78	7.34	6.50	7.10	5.02	.36L	.25	.27	.30	.27
70 15.3	3.20	5.48	5.20	.00B	4.23	.00B	.71	.67	.00B	.55
70 26.4	3.50	5.74	4.90	5.70	4.39	11.00	.16	.27	.20	.15
70 28.5	2.58	5.87	5.30	5.50	4.10	.00B	.09	.22	.13	.08
70 112.0	5.12	6.15	5.40	5.90	4.04	5.70	.23	.28	.26	.21
70 113.0	5.16	5.84	5.50	5.60	4.29	.30L	.29	.33	.32	.26
70 143.0	8.79	12.84	7.00	.00B	5.51	12.32	.35	.39	.00B	.24
70 166.1	7.38	13.57	8.20	12.00	4.95	20.10	.41	.49	.43	.35
73 44.1	25.60	5.70	5.30	5.60	3.87	5.35	12.53	11.00	12.00	9.16
73 47.6	2.83	4.46	4.80	.00B	3.63	4.03	.19	.24	.00B	.15
73 103C	6.54	9.53	8.20	8.40	4.44	9.50	.17	.26	.19	.14
73 178.3	2.31	2.26	2.70	2.20	2.10	1.96	.27	.34	.30	.26
78 145C	3.40	4.45	6.40	.00B	3.45	5.10	.04	.08	.00B	.05
79 106.0	5.94	8.92	6.60	8.20	5.76	23.60	.13	.15	.15	.12
79 234.9	3.66	15.92	9.50	13.00	5.82	15.80	1.01	1.10	1.00	.75
80 36C	2.97	6.69	6.00	6.40	4.47	7.50	.05	.08	.07	.05
80 47.6	2.29	4.60	5.30	4.60	3.56	3.95	.06	.08	.09	.07
80 54C	2.48	4.53	5.00	.00B	3.52	4.25	.09	.13	.00B	.08
80 68.2	2.47	4.05	4.20	.65	3.41	.00B	.05	.06	.86	.05L
80 178C	2.37	23.04	11.00	.00B	3.74	23.10	1.23	1.10	.00B	.82
81 72.4	5.79	4.29	4.90	4.10	3.07	4.15	.10	.14	.12	.10
83 158.6	4.58	7.12	5.90	.00B	5.15	6.60	.24	.26	.00B	.19
83 294.9	2.98	7.66	7.20	6.60	5.04	15.00	.44	.53	.43	.42
83 516.8	1.72	14.77	15.00	.00B	5.87	14.70	4.92	4.70	.00B	3.88
97 67.1	1.37	4.21	4.70	4.20	3.38	4.09	11.01	11.00	11.00	10.59
97 86.6	1.92	4.99	5.40	.00B	4.11	4.58	.01	.03	.00B	.05L
97 90.2	5.02	9.11	8.80	8.40	5.00	9.47	4.40	4.40	4.40	3.82
PM 172.2	1.70	.43	.38	.00B	.36	.36	.50	.45	.00B	.43
PM 221.9	2.87	3.23	4.30	.00B	2.64	3.20	.59	.83	.00B	.47

SAMPLE	Ca% N O	K % X G	K % I1 G	K % I2 G	K % I O	K % N O	K % N G	U * I1 G	U * I2 G	U * N O
19 268.5	2.57	3.09	3.50	.00B	1.98	2.93	2.840	100.L	0.B	4.14
19 327.8	15.10	1.10	1.70	1.20	.64	1.12	.988	100.L	100.L	1.23
19 337C	20.20	.12	.22	.00B	.03	.14	.250L	100.L	0.B	3.20
29 17.3	1.71	.01	.05L	.05L	.02L	.00B	.250L	100.L	100.L	39.20
30 343.5	.40L	3.53	3.50	3.60	2.11	3.75	3.700	100.L	100.L	13.30
30 348.5	.11L	.01	.17	.05L	.02	.01L	.250L	400.	300.	310.00
32 47.5	3.56	.12	.16	.14	.08	.15	.250L	200.	200.	12.80
33 27.7	.13L	2.48	3.10	2.40	1.68	2.38	2.440	100.L	100.L	4.93
33 123.7	.27L	5.35	7.60	5.10	3.67	5.32	5.410	100.L	100.L	2.55
38 51.5	.45L	1.95	2.50	2.00	1.48	2.10	.000B	4000.	3900.	3540.00
38 163C	.60L	.02	.06	.00B	.02L	.03	.250L	100.L	0.B	15.00
38 193.8	.18L	.01	.05L	.00B	.02L	1.00L	.039	100.L	0.B	13.20
55 138.2	4.70	3.27	3.80	.00B	2.06	3.58	3.320	100.	0.B	64.10
55 194.9	.19L	.01	.06	.05L	.02	.00B	.250L	100.L	100.L	9.03
56 22C	.20L	.57	.70	.60	.24	.71	.704	1500.	1500.	1200.00
59 64.8	.08L	1.54	2.10	.00B	.92	1.76	1.760	100.L	0.B	3.00
61 258C	.58	.02	.05L	.00B	.02	.03	.250L	100.L	0.B	23.80
64 103.0	.10L	.01	.05L	.00B	.02L	.02L	.250L	100.L	0.B	12.60
64 138.0	14.00	.01	.05L	.05L	.02L	.00L	.120	100.L	100.L	10.10
64 151.4	.09L	3.25	5.20	2.90	2.33	3.52	3.200	100.L	100.L	6.01
64 194.0	.42L	.01	.05L	.05L	.02L	.00B	.290	1900.	1900.	1900.00
65 92.8	2.60L	.06	.05L	.05L	.02	.00B	.250L	43000.	42000.	36100.00
70 15.3	1.10L	.05	.07	.00B	.04	.00B	.250L	2200.	0.B	2200.00
70 26.4	.61L	.26	.31	.28	.21	.25	.550	5900.	6100.	5400.00
70 28.5	.51L	.24	.29	.26	.18	.00B	.650	4100.	3900.	2000.00
70 112.0	.31L	.37	.52	.41	.28	.45	.427	400.	400.	333.00
70 113.0	.82L	.06	.09	.07	.05	.00B	.250L	8200.	7600.	6100.00
70 143.0	.54L	.03	.08	.00B	.03	.05	.250L	100.L	0.B	3.23
70 166.1	1.10L	.02	.06	.05L	.02L	.00B	.250L	16000.	13000.	12200.00
73 44.1	11.50	.01	.05L	.05L	.02L	.03L	.250L	200.	200.	146.00
73 47.6	.42L	2.50	2.60	.00B	1.63	2.15	2.640	100.L	0.B	26.80
73 103C	.20L	2.53	3.40	2.60	1.52	2.94	2.440	2700.	1800.	1700.00
73 178.3	.54L	4.03	5.80	4.00	2.74	4.01	4.000	100.L	100.L	7.24
78 145C	.50L	2.81	3.70	.00B	1.10	2.73	2.650	4100.	0.B	4650.00
79 106.0	1.00L	.34	.47	.36	.24	.31L	.980	15000.	13000.	16100.00
79 234.9	.82	.71	.93	.78	.49	.92	.749	100.	100.L	17.60
80 36C	.40L	.43	.58	.46	.23	.40	.559	3800.	4000.	4200.00
80 47.6	1.50L	.71	.88	.74	.54	.00B	.250L	21000.	21000.	24300.00
80 54C	.28L	1.46	1.60	.00B	.72	1.61	1.550	800.	0.B	900.00
80 68.2	.30L	.77	.90	3.00	.56	.79	.992	1500.	100.L	1700.00
80 178C	1.21	.02	.05L	.00B	.02L	.04	.250L	100.L	0.B	47.00
81 72.4	.20L	2.26	2.80	2.30	1.50	2.24	2.560	100.L	100.L	40.60
83 158.6	.20	.60	.77	.00B	.40	.66	.650	100.L	0.B	9.80
83 294.9	1.70L	.07	.08	.06	.04	.00B	.250L	19000.	16000.	15700.00
83 516.8	5.00	1.33	1.70	.00B	.72	1.43	1.520	100.L	0.B	4.40
97 67.1	10.40	.01	.05L	.05L	.02L	.00B	.250L	100.	100.L	35.20
97 86.6	.08L	2.09	2.40	.00B	1.59	1.60L	2.190	100.L	0.B	13.20
97 90.2	4.10	1.10	1.50	1.20	.72	.80L	1.240	2900.	2700.	2380.00
PM 172.2	.50	5.18	4.90	.00B	3.08	5.43	5.250	100.L	0.B	6.20
PM 221.9	.51	3.73	5.40	.00B	2.06	3.75	3.910	100.L	0.B	12.20

Ranger Uranium Mine Duplicate Analyses - continued

SAMPLE	U * N G	U * D G	As* I1 G	As* I2 G	As* N O	Ba* I1 G	Ba* I2 G	Ba* I O	Ba* N O	Ba* N G
19 268.5	3.52	4.98	10.L	0.B	2.00L	950.	0.B	836.	897.	949.
19 327.8	1.01	1.40	10.L	10.L	.40L	480.	120.	90.	842.L	104.
19 337C	2.58	3.83	10.	0.B	.25L	2.	0.B	8.	440.L	35.L
29 17.3	32.10	45.30	10.L	10.L	.30L	23.	21.	21.	130.L	54.
30 343.5	12.00	16.20	80.	50.	10.30	200.	23.	178.	284.	253.
30 348.5	234.00	368.00	50.	50.	13.20	74.	33.	44.	320.L	130.
32 47.5	107.00	151.00	10.L	10.L	2.30	12.	16.	14.	502.L	35.L
33 27.7	5.29	6.16	10.L	10.L	.70L	260.	270.	208.	297.	279.
33 123.7	2.14	3.03	10.L	10.L	.20L	530.	450.	425.	395.	468.
38 51.5	2890.00	3890.00	30.	10.	8.00	210.	220.	186.	4700.	2400.
38 163C	11.30	15.40	10.L	0.B	.52L	1.L	0.B	7.	700.L	35.L
38 193.8	11.10	14.70	10.L	0.B	.37L	6.	0.B	9.	160.L	35.L
55 138.2	54.70	74.40	10.	0.B	4.00L	45.	0.B	44.	140.L	65.
55 194.9	8.59	10.40	10.L	10.L	.30L	14.	15.	14.	200.L	35.L
56 22C	1150.00	1570.00	10.L	10.L	1.00	110.	110.	84.	552.	600.
59 54.8	3.17	3.50	10.L	0.B	2.90L	220.	0.B	178.	172.	150.
61 258C	22.50	25.00	10.L	0.B	.28L	7.	0.B	14.	170.L	35.L
64 103.0	10.90	15.00	10.L	0.B	.20L	26.	0.B	30.	88.L	36.
64 138.0	8.46	12.50	10.L	10.L	.09L	5.	2.	2.L	1200.L	37.
64 151.4	5.36	7.10	20.	10.L	.50L	360.	280.	232.	317.	323.
64 194.0	1480.00	1900.00	10.L	10.L	2.00L	28.	37.	33.	1800.L	380.
65 92.8	25900.00	36900.00	30.	20.	.008	410.	380.	336.	45000.	31000.
70 15.3	1830.00	2340.00	10.L	0.B	1.00L	74.	0.B	72.	3200.L	300.
70 26.4	4220.00	5980.00	10.	10.L	6.30	79.	78.	70.	8300.	3700.
70 28.5	2910.00	3220.00	10.L	10.L	2.00L	95.	92.	77.	3070.	474.
70 112.0	274.00	408.00	10.L	10.L	.60L	52.	38.	33.	1400.L	100.
70 113.0	5540.00	7220.00	10.L	10.L	7.00L	62.	51.	45.	18000.L	2200.
70 143.0	2.72	3.74	10.L	0.B	.40L	8.	0.B	9.	256.L	35.L
70 166.1	9200.00	12700.00	10.L	10.L	.008	130.	140.	126.	20000.	12000.
73 44.1	131.00	178.00	10.L	10.L	6.65	5.	9.	9.	1000.L	50.
73 47.6	23.50	31.90	10.L	0.B	2.38	150.	0.B	159.	155.	188.
73 103C	1470.00	1970.00	10.	10.L	3.20L	320.	280.	227.	1300.	550.
73 178.3	6.86	8.85	10.L	10.L	.90L	490.	480.	456.	850.L	501.
78 145C	2650.00	3360.00	10.L	0.B	.91L	280.	0.B	209.	5000.	960.
79 106.0	8810.00	12800.00	10.	10.L	8.00L	70.	120.	57.	32000.L	12000.
79 234.9	14.70	20.80	10.L	10.L	.30L	39.	58.	47.	390.L	54.
80 36C	2620.00	3760.00	10.	10.L	6.00	100.	95.	74.	4300.	480.
80 47.6	16000.00	20500.00	20.	20.	6.00L	190.	170.	146.	47000.L	16000.
80 54C	653.00	834.00	10.L	0.B	.90L	140.	0.B	123.	582.	299.
80 68.2	1270.00	1670.00	10.L	10.L	2.00L	100.	1000.	96.	808.L	268.
80 178C	36.10	48.50	10.L	0.B	72L	1.L	0.B	18.	922.L	37.
81 72.4	37.20	47.90	10.L	10.L	.80L	88.	88.	67.	450.L	110.
83 158.6	9.20	11.40	10.L	0.B	.49L	8.	0.B	8.	160.L	35.L
83 294.9	12300.00	16500.00	10.	10.L	.008	33.	16.	13.	27000.	3500.
83 516.8	3.74	4.59	10.L	0.B	.44L	84.	0.B	73.	280.L	90.
97 67.1	27.30	41.00	10.L	10.L	6.00	33.	33.	31.	88.	53.
97 86.6	10.20	14.50	10.L	0.B	4.80	130.	0.B	128.	140.L	137.
97 90.2	2050.00	2630.00	10.	10.L	3.00L	240.	420.	210.	4800.	2100.
PM 172.2	5.40	7.20	10.L	0.B	2.50L	1100.	0.B	1115.	1000.L	1290.
PM 221.9	10.40	13.60	20.	0.B	.71L	340.	0.B	300.	246.	355.

Ranger Uranium Mine Dupl cate Analyses - continued

SAMPLE	Be* I1 G	Be* I2 G	Be* I O	Cd* I1 G	Cd* I2 G	Ce* I1 G	Ce* I2 G	Ce* I O	Ce* N O	Ce* N G
19 268.5	2.	0.B	2.	2.L	0.B	89.	0.B	76.	76.30	92.90
19 327.8	1.	1.	1.	2.L	2.L	35.	32.	35.	31.80	34.80
19 337C	1.L	0.B	1.L	2.L	0.B	4.L	0.B	10.L	2.47	2.93
29 17.3	1.L	1.	1.	2.L	2.L	4.	4.L	10.L	3.76	4.43
30 343.5	6.	5.	5.	3.	2.L	30.	53.	51.	64.20	66.40
30 348.5	1.	1.L	1.	2.L	2.L	4.L	4.L	10.L	10.00L	4.00
32 47.5	5.	4.	3.	6.	2.L	78.	61.	63.	89.90	75.60
33 27.7	4.	3.	2.	2.	2.L	13.	27.	11.	26.40	28.00
33 123.7	3.	2.	2.	2.L	2.L	4.L	4.L	10.L	1.66	2.31
38 51.5	5.	4.	4.	2.L	2.L	5.	4.L	10.L	980.00L	135.00
38 163C	1.L	0.B	1.	2.L	0.B	14.	0.B	10.L	14.50	14.00
38 193.8	9.	0.B	8.	3.	0.B	4.L	0.B	10.L	1.00L	.23
55 138.2	5.	0.B	4.	2.L	0.B	110.	0.B	140.	34.00L	166.00
55 194.9	13.	13.	11.	2.L	2.L	4.L	4.L	10.	2.47	1.10
56 22C	4.	4.	3.	3.	2.L	6.	5.	10.L	31.20	30.00
59 64.8	3.	0.B	3.	4.	0.B	770.	0.B	508.	596.00	663.00
61 258C	8.	0.B	7.	2.L	0.B	4.L	0.B	10.L	11.00	3.50
64 103.0	1.	0.B	1.	2.L	0.B	4.L	0.B	10.L	1.34	2.30L
64 138.0	1.L	1.L	1.	2.L	2.L	4.L	4.L	10.L	1.00L	2.20
64 151.4	6.	3.	3.	2.L	2.L	4.L	9.	10.L	14.00	14.00
64 194.0	6.	7.	5.	2.L	2.L	6.	4.L	12.	500.00L	32.00
65 92.8	13.	15.	11.	2.L	2.L	81.	59.	45.	.00B	0.00H
70 15.3	3.	0.B	3.	2.L	0.B	12.	0.B	21.	13.00L	37.00
70 26.4	4.	5.	4.	2.L	2.L	6.	4.L	10.L	2000.00L	0.00H
70 28.5	10.	9.	8.	2.L	2.L	4.L	4.L	24.	500.00L	33.00
70 112.0	5.	4.	4.	2.	2.L	4.L	4.L	10.L	7.09	3.00
70 113.0	4.	4.	4.	2.L	2.L	6.	4.L	10.L	460.00L	106.00
70 143.0	6.	0.B	5.	4.	0.B	4.L	0.B	10.L	2.00L	1.00
70 166.1	12.	13.	11.	3.	2.L	12.	8.	10.L	.00B	0.00H
73 44.1	2.	2.	1.	14.	3.	23.	22.	25.	80.30	34.40
73 47.6	3.	0.B	2.	2.L	0.B	7.	0.B	44.	38.70	52.40
73 103C	5.	4.	4.	5.	2.L	4.	5.	10.L	9.30	59.00
73 178.3	5.	4.	4.	2.L	2.L	170.	190.	172.	18.10	215.00
78 145C	8.	0.B	4.	2.L	0.B	4.L	0.B	10.	260.00L	58.00
79 106.0	6.	7.	6.	2.	2.L	68.	48.	63.	4200.00L	0.00H
79 234.9	28.	29.	22.	2.L	2.L	4.	4.	10.L	4.22	4.87
80 36C	5.	5.	4.	2.L	2.L	5.	4.	12.	80.00	55.00
80 47.6	5.	6.	3.	2.L	2.L	39.	21.	22.	1400.00L	0.00H
80 54C	3.	0.B	3.	2.L	0.B	4.L	0.B	10.L	250.00L	24.00
80 68.2	3.	3.	3.	2.L	2.L	14.	94.	24.	400.00L	42.00
80 178C	2.	0.B	2.	2.L	0.B	13.	0.B	10.L	17.60	16.50
81 72.4	3.	3.	2.	2.	2.L	4.L	4.L	10.L	12.00L	1.44
83 158.6	5.	0.B	4.	2.L	0.B	20.	0.B	10.L	10.40	15.40
83 294.9	7.	7.	5.	2.L	2.L	16.	6.	10.L	.00B	0.00H
83 516.8	2.	0.B	2.	2.L	0.B	16.	0.B	20.	15.60	20.40
97 67.1	2.	2.	2.	2.L	2.L	62.	60.	49.	65.50	70.60
97 86.6	5.	0.B	4.	2.L	0.B	230.	0.B	272.	262.00	282.00
97 90.2	9.	9.	8.	4.	2.L	42.	37.	48.	600.00L	144.00
PM 172.2	2.	0.B	2.	2.L	0.B	93.	0.B	92.	101.00	108.00
PM 221.9	6.	0.B	4.	2.L	0.B	88.	0.B	107.	135.00	152.00

Ranger Uranium Mine Duplicate Analyses - continued

SAMPLE	Co* I1 G	Co* I2 G	Co* I O	Co* N O	Co* N G	Cr* I1 G	Cr* I2 G	Cr* I O	Cr* N O	Cr* N G
19 268.5	9.	0.B	10.	10.30	10.50	49.	0.B	51.	49.90	55.50
19 327.8	7.	8.	5.	6.22	5.84	34.	37.	28.	33.30	32.20
19 337C	2.	0.B	4.L	1.88	1.58	4.	0.B	10.	5.11	4.04
29 17.3	15.	17.	15.	18.10	14.70	32.	41.	36.	39.90	33.10
30 343.5	93.	77.	64.	81.50	75.80	220.	200.	161.	187.00	182.00
30 348.5	13.	7.	9.	12.80	11.10	5.	4.	1.	8.60	5.54
32 47.5	74.	61.	48.	54.80	53.90	140.	130.	99.	118.00	115.00
33 27.7	33.	25.	22.	23.70	23.90	290.	230.	207.	209.00	226.00
33 123.7	2.	3.	4.L	1.57	1.85	1.L	3.	1.L	1.00L	1.07
38 51.5	28.	28.	24.	28.30	25.10	110.	100.	108.	132.00	110.00
38 163C	12.	0.B	9.	15.40	9.72	9.	0.B	11.	14.90	8.91
38 193.8	87.	0.B	65.	86.40	73.60	80.	0.B	69.	90.40	79.30
55 138.2	15.	0.B	13.	16.20	13.60	290.	0.B	256.	321.00	285.00
55 194.9	24.	20.	15.	19.50	15.70	19.	19.	10.	16.00	13.60
56 22C	33.	34.	27.	35.90	30.70	68.	81.	60.	85.60	67.30
59 64.8	79.	0.B	54.	67.60	62.30	140.	0.B	109.	138.00	130.00
61 258C	26.	0.B	19.	25.30	2[illegible].60	51.	0.B	44.	57.00	49.60
64 103.0	9.	0.B	8.	10.70	8.36	25.	0.B	29.	34.00	29.70
64 138.0	13.	12.	7.	8.69	8.70	19.	19.	12.	13.60	14.80
64 151.4	30.	17.	16.	19.30	17.50	270.	160.	154.	174.00	173.00
64 194.0	39.	41.	32.	39.90	36.00	50.	50.	43.	59.00	51.60
65 92.8	33.	35.	26.	.00B	20.20	49.	59.	42.	.00B	270.00L
70 15.3	30.	0.B	28.	33.40	30.60	53.	0.B	55.	65.00	60.60
70 26.4	30.	31.	26.	30.70	26.80	140.	170.	134.	183.00	133.00
70 28.5	22.	22.	18.	20.20	10.00	75.	69.	66.	46.50	71.50
70 112.0	44.	40.	35.	40.70	33.10	1.L	3.	1.L	2.30	.69
70 113.0	43.	43.	37.	12.40	37.60	3.	6.	1.L	5.00L	3.40L
70 143.0	72.	0.B	46.	65.30	57.70	6.	0.B	3.	8.60	8.79
70 166.1	68.	59.	49.	.00B	54.00	170.	180.	145.	.00B	151.00
73 44.1	32.	38.	30.	65.50	33.80	83.	100.	72.	179.00	90.00
73 47.6	33.	0.B	21.	21.10	23.30	820.	0.B	497.	427.00	520.00
73 103C	61.	38.	31.	38.80	39.50	290.	220.	186.	240.00	203.00
73 178.3	7.	7.	6.	6.22	1.66	7.	9.	7.	9.33	6.59
78 145C	40.	0.B	29.	39.80	21.50	250.	0.B	145.	185.00	163.00
79 106.0	68.	62.	49.	79.10	51.90	200.	200.	164.	360.00	166.00
79 234.9	38.	32.	26.	36.90	29.90	4.	6.	1.	3.01	2.65
80 36C	30.	29.	24.	37.40	24.70	96.	110.	83.	147.00	82.90
80 47.6	10.	12.	7.	17.10	9.97	73.	83.	57.	224.00	140.00L
80 54C	22.	0.B	19.	23.20	20.90	36.	0.B	36.	46.80	32.00
80 68.2	20.	7.	18.	21.50	20.40	41.	26.	39.	51.00	45.10
80 178C	17.	0.B	12.	22.20	16.40	28.	0.B	27.	38.00	29.40
81 72.4	16.	16.	14.	15.30	15.60	210.	210.	174.	178.00	194.00
83 158.6	37.	0.B	29.	30.20	30.90	20.	0.B	15.	18.60	18.20
83 294.9	48.	38.	37.	.00B	39.10	55.	61.	45.	.00B	52.10
83 516.8	5.	0.B	5.	5.35	5.77	63.	0.B	57.	64.10	71.40
97 67.1	13.	15.	12.	14.40	12.00	100.	130.	110.	113.00	96.90
97 86.6	18.	0.B	16.	16.90	15.40	150.	0.B	138.	139.00	132.00
97 90.2	93.	84.	72.	73.90	79.30	370.	350.	325.	316.00	336.00
PM 172.2	2.	0.B	4.L	3.92	1.52	8.	0.B	9.	12.60	11.00
PM 221.9	10.	0.B	6.	6.69	6.32	170.	0.B	100.	115.00	113.00

Ranger Uranium Mine Duplicate Analyses - continued

SAMPLE	Cs* N O	Cs* N G	Cu* I1 G	Cu* I2 G	Cu* I O	Cu* N O	Dy* I1 G	Dy* I2 G	Dy* N O	Dy* N G
19 268.5	4.40	4.670	11.	0.B	9.	1300.L	6.	0.B	14.00L	5.000
19 327.8	1.89	2.200	18.	14.	9.	662.L	4.L	4.	20.00L	2.900
19 337C	.70	.359	41.	0.B	11.	300.L	4.L	0.B	3.00L	1.400L
29 17.3	.40L	.043	10.	9.	3.	160.L	4.	4.L	2.70L	4.360
30 343.5	7.68	8.430	420.	270.	282.	241.	9.	8.	3.00L	4.130
30 348.5	1.00L	1.110	22000.	21000.	17877.	18000.	4.	4.L	3.80L	1.730
32 47.5	.90L	.657	14.	11.	8.	574.L	13.	7.	10.00L	4.600
33 27.7	1.20	1.540	9.	6.	4.	480.L	8.	5.	5.20L	3.400
33 123.7	2.91	3.650	16.	10.	11.	320.L	4.L	4.L	3.80L	.915
38 51.5	6.20	6.340	1600.	1200.	1213.	1500.L	17.	14.	23.00	.000B
38 163C	.75L	.333	55.	0.B	21.	1500.L	4.L	0.B	16.00L	2.480
38 193.8	.80	.648	10.	0.B	6.	400.L	5.	0.B	1.00L	.473
55 138.2	3.00L	3.190	270.	0.B	128.	400.L	10.	0.B	2.60L	8.100
55 194.9	.30L	.352	29.	70.	3.	464.L	4.L	4.L	4.00L	.470
56 22C	1.60	1.410	240.	200.	105.	740.L	14.	11.	11.00L	7.740
59 64.8	1.20	1.510	11.	0.B	3.	410.L	14.	0.B	1.80L	.812
61 258C	1.50	1.310	590.	0.B	424.	455.	4.L	0.B	2.00L	1.450
64 103.0	.40L	.268	9.	0.B	3.	160.L	4.L	0.B	2.40L	.372
64 138.0	.30L	.034	7.	3.	10.	1400.L	4.L	4.L	28.00L	3.500L
64 151.4	3.10	3.360	44.	20.	20.	420.L	7.	4.L	2.80L	2.320
64 194.0	2.00L	.400	7.	8.	2.L	1000.L	13.	10.	22.00L	9.300
65 92.8	.00B	.990	40.	21.	13.	7000.L	130.	120.	190.00	111.000
70 15.3	1.00L	.540	28.	0.B	22.	1200.L	11.	0.B	9.62	8.200
70 26.4	2.00L	1.030	160.	130.	130.	1600.L	17.	12.	29.00	9.740
70 28.5	.90L	.820	1400.	1100.	1058.	1600.L	10.	11.	24.00L	6.290
70 112.0	10.20	9.430	7.	6.	5.	430.L	4.L	4.L	7.50L	1.010
70 113.0	.40L	1.680	15.	13.	10.	2000.L	27.	19.	71.00L	22.300
70 143.0	1.40	.884	60.	0.B	29.	450.L	7.	0.B	5.30L	.563
70 166.1	.00B	.680	69.	36.	35.	2100.L	50.	38.	47.00	33.100
73 44.1	3.60L	1.100L	47.	46.	37.	282.L	27.	16.	4.20L	8.770
73 47.6	2.80	3.380	10.	0.B	7.	412.L	5.	0.B	2.60L	2.000
73 103C	1.70L	2.060	48.	18.	7.	920.L	20.	13.	14.00L	9.700
73 178.3	4.66	5.000	18.	12.	10.	850.L	19.	16.	3.90L	7.350
78 145C	17.20	17.400	470.	0.B	213.	2000.L	14.	0.B	18.00L	11.100
79 106.0	6.40L	1.090	12.	10.	9.	2900.L	44.	31.	51.40	25.000
79 234.9	14.80	14.000	2400.	1800.	1585.	1800.	4.L	4.L	7.80L	1.650
80 36C	1.90	1.240	160.	150.	132.	1500.L	16.	13.	24.00L	9.370
80 47.6	2.10L	4.010	78.	40.	34.	3500.L	79.	66.	67.80	66.300
80 54C	3.26	3.020	42.	0.B	14.	440.L	6.	0.B	6.00L	4.630
80 68.2	1.40	1.220	290.	14.	243.	1100.L	8.	8.	12.00L	6.170
80 178C	.97L	.167	5.	0.B	4.	1100.L	4.L	0.B	4.00L	2.510
81 72.4	12.60	14.400	14.	13.	3.	470.L	5.	4.L	12.00L	2.300
83 158.6	1.17	1.850	5.	0.B	2.	400.L	4.L	0.B	1.00L	.480
83 294.9	.00B	1.480	3300.	2200.	2170.	3000.	38.	32.	.00B	35.100
83 516.8	4.90	6.250	7.	0.B	4.	360.L	4.	0.B	2.30L	1.170
97 67.1	1.25	1.050	32.	14.	9.	230.L	9.	10.	4.90L	8.270
97 86.6	1.90	2.190	27.	0.B	14.	260.L	5.	0.B	2.80L	3.250
97 90.2	1.90	2.140	310.	230.	114.	1100.L	19.	15.	19.00L	8.180
PM 172.2	2.64	2.670	10.	0.B	15.	740.L	6.	0.B	9.00L	4.350
PM 221.9	8.50	9.530	270.	0.B	139.	820.L	9.	0.B	11.40L	7.000

Ranger Uranium Mine Duplicate Analyses - continued

SAMPLE	Er* I1 G	Er* I2 G	Er* N O	Eu* I1 G	Eu* I2 G	Eu* N O	Eu* N G	Ga* I1 G	Ga* I2 G	Ga* N O
19 268.5	4.L	0.B	574.L	2.L	0.B	1.87	1.280	20.	0.B	.0B
19 327.8	4.L	4.L	744.L	2.L	2.L	1.53	.967	7.	8.	.0B
19 337C	4.L	0.B	400.L	2.L	0.B	.05	.086	4.L	0.B	1.9L
29 17.3	4.L	4.L	340.L	2.L	2.L	1.36	.774	15.	14.	15.0
30 343.5	4.L	4.L	130.L	2.L	2.L	1.01	.646	46.	31.	31.0
30 348.5	4.L	4.L	620.L	2.L	2.L	.40L	.169	6.	4.L	8.0L
32 47.5	4.L	4.L	620.L	2.L	2.L	2.20	1.410	84.	60.	59.5
33 27.7	4.L	4.L	490.L	2.L	2.L	.78	.561	50.	35.	.0B
33 123.7	4.L	4.L	340.L	2.L	2.L	2.64	.173	25.	19.	15.0L
38 51.5	7.	5.	1900.L	2.L	2.	3.36	1.980	32.	35.	36.0
38 163C	4.L	0.B	1600.L	2.L	0.B	.58	.740	4.L	0.B	3.7L
38 193.8	4.L	0.B	300.L	2.L	0.B	.08	.091	46.	0.B	41.9
55 138.2	4.L	0.B	230.L	2.L	0.B	3.69	2.010	39.	0.B	36.0
55 194.9	4.L	4.L	152.L	2.L	2.L	.50L	.062	37.	27.	3.0L
56 22C	4.L	4.L	810.L	2.L	2.L	1.70L	1.410	40.	41.	51.0
59 64.8	4.L	0.B	260.L	2.	0.B	.94	1.630	58.	0.B	20.0L
61 258C	4.L	0.B	310.L	2.L	0.B	.57L	.139	27.	0.B	22.0
64 103.0	4.L	0.B	93.L	2.L	0.B	.14	.075	10.	0.B	17.0
64 138.0	4.L	4.L	2200.L	2.L	2.L	.16	.292	5.	4.	.0B
64 151.4	4.L	4.L	240.L	2.L	2.L	.81	.492	81.	41.	43.0
64 194.0	4.L	4.L	1400.L	2.	2.	3.80	2.250	37.	40.	.0B
65 92.8	36.	37.	1300.L	30.	30.	.00B	30.100	4.L	55.	.0B
70 15.3	4.L	0.B	1200.L	2.	0.B	3.00	2.080	24.	0.B	.0B
70 26.4	4.L	4.	2300.L	2.L	2.L	2.30	1.190	24.	36.	12.0L
70 28.5	4.L	4.L	1600.L	2.L	2.L	1.60	.978	35.	44.	.0B
70 112.0	4.L	4.L	670.L	2.L	2.L	.34	.145	47.	38.	35.0
70 113.0	7.	7.	2900.L	2.	2.	1.01	2.480	28.	38.	.0B
70 143.0	4.L	0.B	200.L	2.L	0.B	.30L	.147	75.	0.B	66.0
70 166.1	8.	11.	6400.L	11.	10.	.00B	9.930	100.	83.	.0B
73 44.1	4.L	4.L	636.L	4.	4.	9.86	3.540	35.	21.	31.0
73 47.6	4.L	0.B	104.L	2.L	0.B	.58	.549	58.	0.B	27.0
73 103C	4.L	4.L	1000.L	2.L	2.L	2.10	1.740	94.	60.	67.0
73 178.3	4.L	4.L	310.L	2.L	2.L	.94	.578	25.	19.	.0B
78 145C	4.L	0.B	2000.L	2.L	0.B	2.29	2.460	46.	0.B	38.0L
79 106.0	8.	11.	81000.L	5.	5.	9.11	4.520	12.	50.	5.3L
79 234.9	4.L	4.L	322.L	2.L	2.L	2.90	.177	22.	20.	20.9
80 36C	4.L	4.L	2000.L	2.	2.	1.90	2.020	31.	40.	45.0
80 47.6	25.	21.	1400.L	12.	13.	21.50	14.100	4.L	22.	.0B
80 54C	4.L	0.B	500.L	2.L	0.B	.44	.665	29.	0.B	2.8
80 68.2	4.L	4.L	1000.L	2.L	2.L	1.30	.752	25.	18.	51.0
80 178C	4.L	0.B	844.L	2.L	0.B	.65	.874	9.	0.B	9.2
81 72.4	4.L	4.L	850.L	2.L	2.L	.41	.266	34.	28.	22.0
83 158.6	4.L	0.B	300.L	2.L	0.B	.05	.103	51.	0.B	42.4
83 294.9	12.	12.	54.	3.	3.	.00B	3.490	10.	38.	.0B
83 516.8	4.L	0.B	510.L	2.L	0.B	.16	.336	15.	0.B	16.0
97 67.1	4.L	6.	230.L	2.	2.	3.36	1.920	16.	19.	20.0
97 86.6	4.L	0.B	110.L	2.L	0.B	1.57	.924	49.	0.B	.0B
97 90.2	4.L	4.L	1800.L	3.	3.	3.28	2.510	74.	71.	63.0L
PM 172.2	4.L	0.B	700.L	2.L	0.B	.48	.846	14.	0.B	70.0L
PM 221.9	4.L	0.B	860.L	2.L	0.B	.60	1.090	48.	0.B	30.0

Ranger Uranium Mine Dupl cate Analyses - continued

SAMPLE	Gd* I1 G	Gd* I2 G	Gd* N O	Gd* N G	Ho* I1 G	Ho* I2 G	Ho* N O	La* I1 G	La* I2 G	La* I O
19 268.5	10.L	0.B	2000.L	6.170	4.L	0.B	130.L	53.	0.B	38.
19 327.8	10.L	10.L	1300.L	3.880	4.L	4.L	14.L	51.	48.	36.
19 337C	10.L	0.B	5000.L	.408	4.L	0.B	9.	7.	0.B	2.L
29 17.3	10.L	10.L	430.	4.450	4.L	4.L	7.L	7.	6.	5.
30 343.5	10.L	10.L	1400.L	4.550	4.L	4.L	34.L	18.	36.	20.
30 348.5	10.L	10.L	1200.L	1.490	4.L	4.L	35.L	2.L	2.L	2.
32 47.5	10.L	10.L	3500.L	5.930	4.L	4.L	22.L	83.	69.	44.
33 27.7	10.L	10.L	1100.L	.000B	4.L	4.L	21.L	13.	20.	7.
33 123.7	10.L	10.L	590.L	.800	4.L	4.L	0.	2.L	2.L	2.L
38 51.5	10.L	10.L	21000.L	10.700	4.L	4.L	40.L	2.	3.	2.L
38 163C	10.L	0.B	8000.L	3.220	4.L	0.B	21.L	24.	0.B	17.
38 193.8	10.L	0.B	1500.L	.740L	4.L	0.B	7.L	2.L	0.B	2.L
55 138.2	10.L	0.B	3300.	9.310	4.L	0.B	74.L	90.	0.B	93.
55 194.9	10.L	10.L	1400.L	.000B	4.L	4.L	17.L	2.	2.L	2.L
56 22C	10.L	10.L	8000.L	.000B	4.L	4.L	0.B	4.	3.	2.L
59 64.8	10.L	0.B	2800.L	.000B	4.L	0.B	75.L	680.	0.B	423.
61 258C	10.L	0.B	1000.L	1.390	4.L	0.B	11.L	2.	0.B	2.L
64 103.0	10.L	0.B	440.L	.400	4.L	0.B	1.L	2.L	0.B	2.L
64 138.0	10.L	10.L	4400.L	1.390	4.L	4.L	1.L	2.L	2.L	2.L
64 151.4	10.L	10.L	1600.L	.000B	4.L	4.L	1.L	4.	8.	4.
64 194.0	10.L	10.L	10000.L	15.000	4.L	4.L	7.L	2.L	2.	2.L
65 92.8	60.	100.	48000.L	109.000	15.	20.	0.B	9.	6.	4.
70 15.3	10.L	0.B	4000.L	8.800	4.L	0.B	37.L	10.	0.B	7.
70 26.4	10.L	10.L	7400.L	6.200	4.L	4.L	51.L	2.	2.	2.L
70 28.5	10.L	10.L	16000.L	7.200	4.L	4.L	58.L	2.L	2.L	2.L
70 112.0	10.L	10.L	9100.L	.000B	4.L	4.L	14.L	2.L	2.	2.
70 113.0	10.	10.	9400.L	14.200	4.L	4.L	0.B	2.L	2.L	2.L
70 143.0	10.L	0.B	1500.L	.000B	4.L	0.B	8.L	2.L	0.B	2.L
70 166.1	40.	30.	3000.	35.700	5.	5.	0.B	3.	2.L	2.L
73 44.1	10.	10.L	1700.L	13.300	4.L	4.L	4.L	20.	19.	6.
73 47.6	10.L	0.B	2200.L	.000B	4.L	0.B	19.L	16.	0.B	31.
73 103C	10.L	10.L	6000.L	9.540	4.L	4.L	79.L	3.	4.	2.L
73 178.3	10.L	10.L	4500.	13.500	4.L	4.L	28.L	78.	100.	74.
78 145C	10.L	0.B	18000.L	12.400	4.L	0.B	97.L	2.L	0.B	2.L
79 106.0	10.	20.	83400.	25.000	4.L	5.	200.L	53.	44.	33.
79 234.9	10.L	10.L	3600.L	1.600	4.L	4.L	30.L	2.L	2.L	2.L
80 36C	10.L	10.L	15000.L	8.210	4.L	4.L	85.L	2.L	2.L	2.L
80 47.6	60.	60.	104000.	74.300	9.	11.	0.B	10.	7.	4.
80 54C	10.L	0.B	6000.L	3.900	4.L	0.B	38.L	3.	0.B	2.L
80 68.2	10.L	10.L	10000.L	5.700	4.L	4.L	29.L	13.	58.	11.
80 178C	10.L	0.B	10000.L	3.370	4.L	0.B	0.B	21.	0.B	14.
81 72.4	10.L	10.L	950.L	.000B	4.L	4.L	0.L	2.L	2.L	2.L
83 158.6	10.L	0.B	1600.L	.000B	4.L	0.B	23.L	21.	0.B	7.
83 294.9	10.L	10.L	17000.L	.000B	4.	6.	0.B	3.	2.	2.
83 516.8	10.L	0.B	880.L	.000B	4.L	0.B	25.L	8.	0.B	7.
97 67.1	10.L	10.L	1200.	8.990	4.L	4.L	3.	65.	59.	40.
97 86.6	10.L	0.B	1000.L	.000B	4.L	0.B	76.L	220.	0.B	217.
97 90.2	10.	10.L	9500.L	14.000	4.L	4.L	65.L	37.	35.	29.
PM 172.2	10.L	0.B	1700.L	.000B	4.L	0.B	180.L	53.	0.B	49.
PM 221.9	10.L	0.B	1500.L	9.830	4.L	0.B	26.L	44.	0.B	56.

Ranger Uranium Mine Duplicate Analyses - continued

SAMPLE	La* N O	La* N G	Li* I1 G	Li* I2 G	Li* I O	Lu* N O	Lu* N G	Mn* X G	Mn* I1 G	Mn* I2 G
19 268.5	47.10	48.00	52.	0.B	36.	.20L	.400	387.	470.	0.B
19 327.8	45.20	42.90	120.	94.	66.	.10L	.163	1007.	1200.	1000.
19 337C	1.89	1.74	17.	0.B	11.	.04	.000B	387.	670.	0.B
29 17.3	6.92	5.42	46.	36.	34.	.08L	.180	155.L	110.	85.
30 343.5	39.50	37.10	72.	69.	55.	.60L	.380	155.L	170.	82.
30 348.5	5.43	1.55	62.	26.	19.	.20L	.000B	155.L	49.	16.
32 47.5	68.50	62.70	310.	200.	145.	.20L	.285	232.	600.	330.
33 27.7	17.60	18.00	130.	92.	82.	.20L	.370	155.L	340.	200.
33 123.7	.96	1.03	48.	30.	30.	.05L	.043	155.L	180.	130.
38 51.5	36.60	23.30	160.	120.	115.	.05L	.000B	155.L	120.	83.
38 163C	27.10	23.20	33.	0.B	32.	.18L	.000B	929.	870.	0.B
38 193.8	.51	.41	220.	0.B	147.	.21L	.050	155.L	240.	0.B
55 138.2	145.00	123.00	74.	0.B	52.	.60L	.490	155.L	66.	0.B
55 194.9	1.76	1.47	480.	310.	269.	.20L	.030	155.L	130.	82.
56 22C	18.30	8.19	150.	120.	76.	.41L	.000B	155.L	160.	130.
59 64.8	545.00	495.00	190.	0.B	101.	.27L	.180	155.L	260.	0.B
61 258C	2.86	2.33	600.	0.B	346.	.14L	.460L	155.L	230.	0.B
64 103.0	1.77	1.57	42.	0.B	33.	.07L	.020	155.L	47.	0.B
64 138.0	.87	.88	24.	33.	18.	.07L	.047	2633.	3400.	2500.
64 151.4	8.92	7.96	160.	96.	103.	.20L	.370	155.L	110.	46.
64 194.0	27.60	8.28	170.	140.	119.	.50L	.000B	155.L	180.	140.
65 92.8	.00B	328.00	370.	260.	221.	.00B	.000B	542.	740.	630.
70 15.3	38.10	14.90	150.	0.B	108.	.50L	.000B	155.L	86.	0.B
70 26.4	60.60	31.10	210.	170.	159.	.50L	.000B	155.L	160.	100.
70 28.5	58.70	10.40	240.	180.	158.	.30L	.000B	155.L	100.	79.
70 112.0	11.70	3.01	180.	130.	109.	.10L	.000B	155.L	180.	120.
70 113.0	162.00	32.90	160.	120.	102.	.20L	.000B	155.L	240.	150.
70 143.0	.46	.41	210.	0.B	124.	.20L	.024	155.L	280.	0.B
70 166.1	.00B	83.80	550.	350.	307.	.00B	.000B	155.	480.	260.
73 44.1	33.20	19.00	88.	75.	51.	.90L	.410	155.	340.	74.
73 47.6	43.40	49.50	87.	0.B	66.	.20L	.157	155.L	88.	0.B
73 103C	31.10	10.40	250.	200.	164.	.47L	.000B	155.L	360.	140.
73 178.3	95.40	92.80	61.	44.	41.	.10L	.000B	232.	330.	270.
78 145C	28.40	16.40	170.	0.B	96.	.74L	.000B	155.L	140.	0.B
79 106.0	268.00	91.00	340.	250.	207.	1.70L	.000B	155.L	270.	170.
79 234.9	2.24	1.72	590.	430.	333.	.22	.000B	155.L	320.	210.
80 36C	77.20	16.30	210.	150.	114.	.73L	.000B	155.L	140.	110.
80 47.6	194.00	189.00	110.	83.	74.	2.20L	.000B	232.	390.	340.
80 54C	7.91	6.46	130.	0.B	74.	.25L	.000B	155.L	120.	0.B
80 68.2	32.80	17.10	130.	53.	93.	.30L	.000B	155.L	76.	310.
80 178C	28.70	22.00	67.	0.B	59.	.23L	.160	1859.	1600.	0.B
81 72.4	2.15	1.26	130.	110.	90.	.20L	.022	387.	520.	390.
83 158.6	15.00	13.80	220.	0.B	128.	.11L	.023	155.	260.	0.B
83 294.9	.00B	144.00	260.	160.	140.	.00B	.000B	155.L	200.	140.
83 516.8	8.34	8.16	240.	0.B	137.	.11L	.088L	155.L	160.	0.B
97 67.1	62.90	53.50	87.	66.	57.	.10L	.000B	155.L	87.	68.
97 86.6	267.00	257.00	96.	0.B	84.	.20L	.240	155.L	100.	0.B
97 90.2	86.30	44.30	290.	200.	157.	.40L	.000B	155.L	260.	150.
PM 172.2	56.50	53.10	61.	0.B	48.	.12L	.392	155.	240.	0.B
PM 221.9	80.50	77.50	220.	0.B	119.	.25L	.520	620.	950.	0.B

Ranger Uranium Mine Duplicate Analyses - continued

SAMPLE	Mn* I O	Mn* N O	Mn* N G	Na* X G	Na* I1 G	Na* I2 G	Na* I O	Na* N O	Na* N G	Nb* I1 G
19 268.5	398.	476.0	451.	21068.	21000.	0.B	17300.	21300.	21100.	8.
19 327.8	829.	1000.0	937.	1113.L	700.	600.	500.L	438.	455.	4.L
19 337C	364.	494.0	451.	1113.L	300.	0.B	500.L	162.	224.	5.
29 17.3	103.	86.1	87.	1113.L	90.	200.	500.L	95.	149.	4.L
30 343.5	72.	90.0	90.	1113.L	600.	500.	500.L	359.	422.	14.
30 348.5	17.	21.8	21.	1113.L	300.	300.	500.L	215.	222.	4.L
32 47.5	279.	335.0	329.	1113.L	100.	200.	500.L	127.L	146.	9.
33 27.7	180.	210.0	209.	1187.	2700.	1900.	1500.	1800.	1850.	15.
33 123.7	138.	137.0	147.	1113.L	1800.	1500.	1200.	1300.	1420.	4.L
38 51.5	82.	96.0	0.B	1113.L	300.	400.	500.L	380.	310.	6.
38 163C	766.	894.0	850.	1113.L	300.	0.B	500.L	341.	340.	4.L
38 193.8	120.	149.7	147.	1113.L	50.L	0.B	500.L	81.	136.	11.
55 138.2	34.	44.0	43.	1113.L	100.	0.B	500.L	167.	214.	10.
55 194.9	62.	80.0	82.	1113.L	1600.	1400.	900.	1100.	1150.	7.
56 22C	105.	124.0	136.	1113.L	200.	300.	500.L	234.	265.	5.
59 64.8	107.	125.1	129.	1113.L	400.	0.B	500.L	428.	511.	17.
61 258C	148.	183.3	186.	1113.L	300.	0.B	500.L	337.	407.	10.
64 103.0	38.	41.9	41.	1113.L	70.	0.B	500.L	126.	147.	4.L
64 138.0	1706.	2400.0	2370.	1113.L	50.L	100.	500.L	510.L	113.	4.L
64 151.4	43.	53.0	51.	1113.L	1800.	1400.	1300.	1400.	1490.	26.
64 194.0	114.	145.0	153.	1113.L	100.	200.	500.L	270.L	218.	6.
65 92.8	581.	650.0	738.	1113.L	200.	300.	500.L	1200.L	298.	4.
70 15.3	60.	75.3	88.	1113.L	50.	0.B	500.L	210.L	153.	4.
70 26.4	102.	130.0	144.	1113.L	100.	200.	500.L	242.L	270.	7.
70 28.5	62.	72.3	97.	1113.L	900.	900.	600.	631.	760.	7.
70 112.0	104.	139.0	135.	1113.L	500.	500.	500.L	482.	458.	7.
70 113.0	138.	170.0	215.	1113.L	300.	300.	500.L	790.L	430.	15.
70 143.0	122.	174.0	161.	1113.L	50.L	0.B	500.L	86.	164.	19.
70 166.1	241.	260.0	357.	1113.L	100.	300.	500.L	380.	290.	33.
73 44.1	66.	85.7	100.	1113.L	50.L	200.	500.L	120.L	104.	4.L
73 47.6	50.	55.8	58.	1113.L	2100.	0.B	900.	1100.	1150.	11.
73 103C	131.	150.5	163.	1335.	1700.	1400.	900.	1200.	1160.	26.
73 178.3	262.	257.0	260.	1113.L	1000.	900.	600.	702.	709.	25.
78 145C	66.	93.0	98.	2077.	1200.	0.B	900.	7000.	1720.	26.
79 106.0	154.	184.0	244.	1113.L	200.	300.	500.L	418.L	289.	14.
79 234.9	176.	224.0	221.	1113.L	100.	300.	500.L	224.	280.	4.L
80 36C	102.	130.4	127.	1113.L	200.	200.	500.L	380.L	205.	6.
80 47.6	283.	317.0	448.	1113.L	200.	200.	500.L	776.L	277.	9.
80 54C	74.	84.0	95.	1113.L	500.	0.B	500.L	417.	498.	10.
80 68.2	61.	73.3	80.	1113.L	200.	26000.	500.L	112.	277.	4.
80 178C	1303.	1600.0	1640.	1113.L	50.L	0.B	500.L	184.	152.	4.L
81 72.4	353.	399.0	418.	1113.L	300.	400.	500.L	205.	290.	9.
83 158.6	145.	221.2	231.	1113.L	500.	0.B	500.L	688.	752.	11.
83 294.9	142.	183.0	215.	1187.	700.	700.	500.	1600.	658.	8.
83 516.8	126.	161.0	162.	1484.	1100.	0.B	800.	1100.	1230.	7.
97 67.1	69.	63.7	67.	1113.L	50.L	100.	500.L	91.	113.	4.L
97 86.6	71.	75.8	77.	1113.L	300.	0.B	500.L	245.	297.	10.
97 90.2	144.	164.0	172.	1113.L	300.	400.	500.L	390.	416.	15.
PM 172.2	235.	255.0	273.	14688.	15000.	0.B	12100.	15000.	16300.	5.
PM 221.9	573.	658.5	691.	1113.L	1300.	0.B	500.L	637.	769.	25.

Ranger Uranium Mine Duplicate Analyses - continued

SAMPLE	Nb* I2 G	Nb* I O	Nd* I1 G	Nd* I2 G	Nd* N O	Nd* N G	Ni* I1 G	Ni* I2 G	Ni* I O	P * X G
19 268.5	0.B	8.	38.	0.B	92.L	37.80	10.	0.B	11.	524.
19 327.8	4.L	5.	38.	30.	8.L	31.60	11.	12.	6.	87.
19 337C	0.B	8.	4.L	0.B	23.L	1.60	6.	0.B	3.	87.
29 17.3	4.L	4.L	4.L	4.L	11.L	7.29	47.	47.	40.	8859.
30 343.5	13.	6.	20.	28.	80.L	27.70	200.	140.	118.	786.
30 348.5	4.L	4.L	4.L	4.L	30.L	3.00	30.	31.	21.	87.
32 47.5	5.	4.	36.	29.	91.L	31.60	190.	130.	102.	17762.
33 27.7	9.	9.	6.	13.	18.L	15.10	93.	64.	54.	305.
33 123.7	4.L	4.L	4.L	4.L	1.L	.00B	5.	5.	2.L	742.
38 51.5	5.	4.L	7.	4.L	800.L	100.00	82.	71.	57.	218.
38 163C	0.B	4.L	16.	0.B	39.L	19.80	16.	0.B	13.	262.
38 193.8	0.B	4.L	4.L	0.B	5.L	.73	550.	0.B	341.	436.
55 138.2	0.B	6.	41.	0.B	60.L	53.50	51.	0.B	36.	22737.
55 194.9	4.L	4.L	4.L	4.L	5.L	.40	150.	110.	79.	567.
56 22C	6.	5.	4.L	5.	60.L	25.00	97.	90.	63.	567.
59 64.8	0.B	7.	210.	0.B	120.L	170.00	150.	0.B	84.	829.
61 258C	0.B	4.	4.L	0.B	16.L	2.50	130.	0.B	83.	1615.
64 103.0	0.B	4.L	4.L	0.B	4.L	1.50	34.	0.B	28.	87.
64 138.0	4.L	7.	4.L	4.L	1.L	1.80	24.	14.	9.	262.
64 151.4	8.	10.	7.	6.	17.L	5.98	130.	60.	54.	87.
64 194.0	4.L	4.L	7.	10.	400.L	48.00	140.	130.	99.	1266.
65 92.8	6.	4.L	87.	82.	0.B	0.00H	110.	90.	74.	698.
70 15.3	0.B	4.	14.	0.B	91.L	33.00	110.	0.B	88.	3666.
70 26.4	7.	4.L	4.	7.	1100.L	0.00H	140.	130.	103.	916.
70 28.5	7.	4.L	4.L	5.	1100.L	14.00	130.	120.	93.	567.
70 112.0	12.	10.	4.L	4.L	80.L	.00B	82.	67.	53.	1047.
70 113.0	5.	11.	7.	7.	2000.L	42.00	89.	77.	62.	1309.
70 143.0	0.B	14.	4.L	0.B	18.L	.00B	140.	0.B	83.	1571.
70 166.1	23.	14.	17.	23.	0.B	0.00H	290.	210.	169.	1702.
73 44.1	4.L	7.	22.	16.	73.L	13.00	74.	69.	50.	57258.
73 47.6	0.B	4.	13.	0.B	17.L	13.00	79.	0.B	51.	1047.
73 103C	19.	9.	8.	7.	88.L	35.00	170.	97.	76.	218.
73 178.3	19.	17.	83.	95.	28.L	92.10	11.	9.	8.	1353.
78 145C	0.B	15.	4.L	0.B	820.L	33.00	100.	0.B	50.	218.
79 106.0	14.	5.	25.	27.	2400.L	0.00H	180.	140.	115.	611.
79 234.9	4.L	4.L	4.L	4.L	5.L	2.87	63.	50.	39.	4364.
80 36C	4.L	4.L	7.	8.	210.L	25.00	140.	120.	92.	262.
80 47.6	4.L	4.L	35.	33.	1700.L	0.00H	37.	36.	27.	305.
80 54C	0.B	6.	4.L	0.B	730.L	11.00	73.	0.B	52.	349.
80 68.2	9.	4.L	5.	40.	200.L	38.00	63.	11.	56.	262.
80 178C	0.B	4.L	13.	0.B	130.L	19.60	58.	0.B	36.	262.
81 72.4	6.	8.	4.L	4.L	20.	.00B	87.	67.	57.	480.
83 158.6	0.B	6.	5.	0.B	42.L	2.97	110.	0.B	73.	1047.
83 29429	4.L	4.L	8.	4.L	0.B	0.00H	190.	140.	123.	436.
83 516.8	0.B	7.	10.	0.B	6.L	9.89	16.	0.B	12.	87.
97 67.1	4.L	4.	31.	31.	40.L	29.60	79.	71.	60.	50188.
97 86.6	0.B	6.	65.	0.B	65.	70.10	110.	0.B	83.	436.
97 90.2	17.	11.	33.	31.	900.L	82.00	280.	220.	184.	19595.
PM 172.2	0.B	8.	39.	0.B	150.L	40.90	4.	0.B	5.	262.
PM 221.9	0.B	13.	46.	0.B	21.L	57.70	35.	0.B	20.	1309.

Ranger Uranium Mine Duplicate Analyses - continued

SAMPLE	P * I1 G	P * I2 G	P * I O	Pb* I1 G	Pb* I2 G	Pb* I O	Rb* N O	Rb* N G	Sc* I1 G	Sc* I2 G
19 268.5	300.	0.B	372.	22.	0.B	28.	149.	131.0	14.	0.B
19 327.8	50.L	200.	73.	4.L	4.	10.L	37.L	31.2	5.	5.
19 337C	50.L	0.B	37.	6.	0.B	10.L	3.L	3.4	2.L	0.B
29 17.3	9500.	9500.	9467.	14.	12.	12.	14.L	2.5L	4.	4.
30 343.5	900.	800.	637.	85.	47.	65.	312.	240.0	17.	18.
30 348.5	50.L	50.L	5.L	130.	85.	85.	37.L	2.5L	2.L	2.L
32 47.5	24000.	18000.	13124.	28.	30.	26.	35.L	2.5L	13.	27.
33 27.7	300.	300.	286.	25.	10.	10.L	86.	68.9	16.	15.
33 123.7	900.	800.	782.	18.	21.	10.L	166.	152.0	2.L	2.L
38 51.5	300.	200.	225.	1800.	2100.	1951.	170.	143.0	25.	20.
38 163C	100.	0.B	132.	15.	0.B	10.L	22.L	2.5L	2.L	0.B
38 193.8	200.	0.B	226.	5.	0.3	10.L	33.L	4.8	2.L	0.B
55 138.2	24000.	0.B	18994.	27.	0.B	30.	77.	58.5	22.	0.B
55 194.9	800.	600.	444.	8.	6.	13.	26.L	2.7	2.	5.
56 22C	400.	500.	479.	300.	370.	236.	35.	38.0	16.	18.
59 64.8	900.	0.B	576.	19.	0.B	10.L	96.	45.4	6.	0.B
61 258C	1700.	0.B	1210.	9.	0.B	10.	20.	4.0	2.L	0.B
64 103.0	60.	0.B	168.	4.	0.B	10.L	9.L	2.5L	2.	0.B
64 138.0	200.	300.	208.	7.	4.L	10.L	9.L	2.5L	2.L	3.
64 151.4	300.	200.	151.	26.	14.	17.	115.	87.5	23.	17.
64 194.0	1100.	1200.	873.	580.	650.	514.	50.L	2.5L	2.L	9.
65 92.8	600.	600.	720.	7400.	8200.	7392.	0.B	.0B	29.	69.
70 15.3	3200.	0.B	3134.	750.	0.B	768.	43.L	2.5L	10.	0.B
70 26.4	1200.	1000.	840.	650.	750.	676.	56.L	25.0	13.	15.
70 28.5	400.	500.	413.	910.	1000.	801.	14.L	2.5L	19.	19.
70 112.0	1100.	1100.	1043.	56.	56.	48.	107.	81.8	5.	5.
70 113.0	1300.	1300.	1277.	1100.	1300.	1105.	23.L	2.5L	18.	20.
70 143.0	1800.	0.B	1210.	13.	0.B	13.	46.L	14.1	3.	0.B
70 166.1	2200.	1800.	1681.	5500.	5400.	4707.	0.B	2.5L	3.	46.
73 44.1	55000.	57000.	40358.	55.	49.	36.	100.L	12.0	14.	12.
73 47.6	1400.	0.B	808.	19.	0.B	12.	90.	75.4	17.	0.B
73 103C	100.	200.	101.	260.	190.	145.	110.	70.1	20.	27.
73 178.3	1700.	1400.	1450.	26.	21.	12.	201.	155.0	5.	4.
78 145C	200.	0.B	150.	1300.	0.B	1019.	240.	174.0	24.	0.B
79 106.0	600.	600.	463.	1100.	1100.	873.	200.L	25.6	17.	34.
79 234.9	5000.	4500.	3222.	69.	58.	85.	112.	74.9	2.L	2.
80 36C	100.	200.	148.	980.	1100.	1021.	80.	32.0	13.	18.
80 47.6	200.	200.	207.	3400.	4000.	3043.	210.L	55.5	42.	32.
80 54C	200.	0.B	223.	150.	0.B	103.	150.	88.9	12.	0.B
80 68.2	100.	300.	191.	560.	22.	556.	36.L	27.0	12.	7.
80 178C	100.	0.B	74.	6.	0.B	10.L	26.L	2.5L	2.L	0.B
81 72.4	500.	500.	469.	13.	6.	10.L	221.	195.0	17.	15.
83 158.6	1000.	0.B	779.	6.	0.B	10.L	27.	22.7	5.	0.B
83 294.9	400.	300.	401.	3900.	3800.	3683.	0.B	2.5L	3.	27.
83 516.8	50.L	0.B	5.L	16.	0.B	19.	51.	47.6	6.	0.B
97 67.1	54000.	52000.	52930.	33.	20.	10.L	14.L	2.6	10.	9.
97 86.6	300.	0.B	334.	16.	0.B	20.	54.	45.6	14.	0.B
97 90.2	24000.	21000.	19744.	540.	570.	476.	74.L	34.3	13.	19.
PM 172.2	90.	0.B	186.	16.	0.B	10.L	216.	169.0	5.	0.B
PM 221.9	1800.	0.B	1000.	14.	0.B	15.	244.	223.0	17.	0.B

Ranger Uranium Mine Dupl cate Analyses - continued

SAMPLE	Sc* I O	Sc* N O	Sc* N G	Sm* I1 G	Sm* N O	Sm* N G	Sn* I1 G	Sn* I2 G	Sr* I1 G	Sr* I2 G
19 268.5	9.	11.00	12.20	10.L	4.70	6.670	4.L	0.B	310.	0.B
19 327.8	3.	4.52	4.64	10.L	3.65	5.070	4.L	4.L	53.	46.
19 337C	1.	.75	.75	10.L	.26	.366	7.	0.B	62.	0.B
29 17.3	3.	4.28	3.77	10.L	1.82	2.670	5.	4.L	10.	8.
30 343.5	9.	21.20	21.00	10.L	4.42	5.110	9.	4.L	14.	12.
30 348.5	1.	.86	.82	10.L	8.64	.800	7.	4.L	8.	6.
32 47.5	13.	25.10	26.40	10.L	4.21	5.790	36.	17.	30.	24.
33 27.7	10.	13.80	15.30	10.L	1.66	2.480	9.	4.L	11.	12.
33 123.7	1.L	.57	.65	10.L	.43	.553	4.L	4.	28.	22.
38 51.5	16.	21.30	19.40	10.L	4.00L	5.400	6.	9.	15.	12.
38 163C	2.	3.38	2.43	10.L	3.69	3.430	6.	0.B	7.	0.B
38 193.8	4.	9.02	8.29	10.L	1.15	.357	12.	0.B	22.	0.B
55 138.2	15.	25.80	23.30	10.L	8.94	8.610	12.	0.B	46.	0.B
55 194.9	3.	5.35	4.56	10.L	.02L	.310	5.	4.L	12.	9.
56 22C	12.	19.10	18.00	10.L	1.30	4.300	29.	17.	7.	4.
59 64.8	10.	15.40	15.20	10.	10.40	12.900	14.	0.B	200.	0.B
61 258C	2.	3.46	3.15	10.L	1.34	1.000	7.	0.B	13.	0.B
64 103.0	2.	2.23	2.03	10.L	.27	.315	4.	0.B	4.	0.B
64 138.0	1.	2.52	2.82	10.L	.58	1.010	4.	4.L	56.	36.
64 151.4	12.	20.00	19.60	10.L	1.10	1.550	8.	4.L	27.	22.
64 194.0	4.	8.55	8.37	10.L	1.00L	12.900	6.	4.L	10.	9.
65 92.8	62.	.00B	70.00	100.	.00B	62.800	28.	4.L	11.	9.
70 15.3	7.	9.89	9.67	10.L	2.00L	8.000	6.	0.B	6.	0.B
70 26.4	12.	14.90	13.90	10.L	4.30	4.500	6.	4.L	7.	4.
70 28.5	12.	14.80	17.80	10.L	2.00L	3.700	5.	4.L	15.	12.
70 112.0	3.	4.78	4.05	10.L	.08L	.600	16.	15.	11.	6.
70 113.0	18.	6.23	20.80	10.	6.00L	7.500	14.	4.L	6.	4.
70 143.0	2.	12.20	11.50	10.L	.02L	.540	25.	0.B	3.	0.B
70 166.1	31.	.00B	44.70	30.	.00B	29.600	11.	4.L	14.	11.
73 44.1	7.	22.30	12.30	10.	12.40	9.270	9.	4.L	32.	33.
73 47.6	12.	16.20	19.80	10.L	1.94	2.070	4.L	0.B	16.	0.B
73 103C	19.	28.80	25.70	10.L	2.20	8.600	33.	10.	17.	11.
73 178.3	4.	4.43	4.44	20.	11.40	17.000	5.	4.L	46.	43.
78 145C	15.	23.70	21.70	10.L	.88L	10.000	31.	0.B	20.	0.B
79 106.0	25.	46.00	31.70	20.	5.40L	18.000	7.	4.L	19.	15.
79 234.9	1.	2.49	2.21	10.L	1.28	1.410	17.	7.	25.	21.
80 36C	14.	24.50	16.60	10.L	3.70	7.100	61.	9.	9.	7.
80 47.6	26.	31.70	35.50	50.	11.00L	48.000	5.	4.L	9.	7.
80 54C	9.	11.90	10.70	10.L	4.25	3.100	95.	0.B	7.	0.B
80 68.2	8.	10.70	10.70	10.L	2.50	3.700	4.L	8.	9.	90.
80 178C	4.	6.27	4.94	10.L	3.59	4.290	4.L	0.B	9.	0.B
81 72.4	10.	14.60	16.00	10.L	.58	.790	6.	4.L	6.	4.
83 158.6	5.	6.25	6.87	10.L	.39	.600	6.	0.B	10.	0.B
83 294.9	26.	.00B	29.90	10.L	.00B	16.000L	4.L	4.L	19.	13.
83 516.8	5.	6.12	7.20	10.L	1.35	1.950	4.	0.B	33.	0.B
97 67.1	7.	8.40	7.71	10.L	5.01	6.630	5.	4.L	50.	45.
97 86.6	10.	12.80	12.90	10.L	3.90	4.960	8.	0.B	83.	0.B
97 90.2	15.	16.60	18.70	10.	4.00L	8.310	11.	7.	29.	24.
PM 172.2	4.	5.30	5.23	10.L	4.16	7.090	8.	0.B	130.	0.B
PM 221.9	11.	15.50	16.00	10.L	3.45	10.700	9.	0.B	17.	0.B

Ranger Uranium Mine Duplicate Analyses - continued

SAMPLE	Sr* I O	Sr* N G	Ta* N O	Ta* N G	Tb* I1 G	Tb* I2 G	Tb* N O	Tb* N G	Th* I1 G	Th* I2 G
19 268.5	263.	356.	.65	.942	20.L	0.B	.70L	.812	19.	0.B
19 327.8	36.	75.L	.50L	.373	20.L	20.L	.40	.486	4.L	4.L
19 337C	33.	75.L	.78L	.055	20.L	0.B	.17L	.061	4.L	0.B
29 17.3	8.	75.L	.70	.968	20.L	20.	.95	.822	4.L	4.L
30 343.5	8.	75.L	8.00L	1.590	20.L	40.	2.00L	.654	12.	22.
30 348.5	5.	75.L	2.00L	.025	20.L	20.	.60L	.270	5.	4.L
32 47.5	19.	75.L	4.00L	.958	20.	20.	.80L	.760	16.	13.
33 27.7	9.	75.L	1.10	1.520	20.L	40.	.40L	.532	12.	19.
33 123.7	19.	75.L	.10L	.195	20.L	20.L	.03L	.177	4.L	4.L
38 51.5	10.	75.L	6.00L	.700	20.L	20.L	2.50	1.720	12.	9.
38 163C	5.	75.L	2.20L	.364	20.L	0.B	.80	.484	4.L	0.B
38 193.8	17.	75.L	1.90	1.880	20.L	0.B	.61L	.072	4.L	0.B
55 138.2	38.	75.L	10.00L	1.310	20.L	0.B	2.00L	1.400	9.	0.B
55 194.9	6.	75.L	3.10	3.350	20.L	30.	.50L	.077	5.	8.
56 22C	3.	75.L	1.20	1.120	20.L	30.	.88L	1.280	20.	18.
59 64.8	142.	167.	1.10	1.900	20.L	0.B	1.00L	.215	45.	0.B
61 258C	9.	75.L	3.76	4.820	20.L	0.B	.39L	.264	4.L	0.B
64 103.0	2.	75.L	.10L	.114	20.L	0.B	.20L	.066	4.L	0.B
64 138.0	27.	75.L	.90L	.125	20.L	20.L	.20L	.221	4.L	4.L
64 151.4	21.	75.L	1.00L	1.710	20.L	20.	.20L	.353	14.	17.
64 194.0	7.	75.L	4.00L	2.680	20.L	40.	1.00L	1.830	21.	27.
65 92.8	8.	75.L	.00B	1.100L	90.	20.	.00B	20.200	62.	4.L
70 15.3	4.	75.L	4.00L	.710	20.L	0.B	.80L	1.470	12.	0.B
70 26.4	4.	75.L	1.80	.500	20.L	20.	1.80	1.350	27.	13.
70 28.5	8.	75.L	3.00L	.893	20.L	30.	.92	.986	17.	11.
70 112.0	5.	75.L	3.00	3.410	20.L	30.	.40L	.138	4.L	4.L
70 113.0	4.	75.L	.80L	5.340	20.	20.L	.90	3.490	11.	4.L
70 143.0	2.	75.L	7.60	9.060	20.L	0.B	.70L	.150	4.L	0.B
70 166.1	9.	75.L	.00B	5.200	50.	30.	.00B	6.930	39.	34.
73 44.1	25.	75.L	7.50L	.603	50.	40.	1.60	1.810	10.	5.
73 47.6	12.	75.L	.30L	.724	20.L	0.B	.60L	.319	11.	0.B
73 103C	9.	75.L	2.20	2.710	20.	30.	.80	1.610	22.	22.
73 178.3	37.	75.L	1.20	1.150	20.L	50.	1.38	1.630	74.	81.
78 145C	15.	75.L	6.00	4.730	20.L	0.B	1.60	1.780	21.	0.B
79 106.0	13.	75.L	17.00L	1.900	40.	40.	3.60L	4.090	72.	41.
79 234.9	16.	75.L	1.12	1.040	20.L	30.	.25L	.270	4.L	4.L
80 36C	6.	0.B	7.10L	1.000L	20.L	20.L	2.80	1.550	20.	10.
80 47.6	5.	75.L	17.00L	1.100	50.	40.	16.00	12.500	57.	6.
80 54C	4.	75.L	2.80	3.210	20.L	0.B	.82L	.690	19.	0.B
80 68.2	6.	75.L	1.00L	.999	20.L	20.	1.40	.972	17.	22.
80 178C	7.	75.L	2.90L	.346	20.L	0.B	.50	.501	4.L	0.B
81 72.4	5.	75.L	1.00	1.090	20.L	30.	.50L	.317	11.	17.
83 158.6	5.	75.L	4.86	9.260	20.L	0.B	.18L	.102	4.L	0.B
83 294.9	12.	75.L	.00B	1.400	40.	30.	.00B	4.740	28.	5.
83 516.8	25.	75.L	.23L	.742	20.L	0.B	.28L	.169	10.	0.B
97 67.1	40.	75.L	2.00L	.228	20.L	30.	1.71	1.420	4.L	4.L
97 86.6	70.	75.L	.90L	.980	20.L	0.B	.60L	.530	13.	0.B
97 90.2	21.	75.L	1.00L	1.500	20.L	20.	1.00	2.050	18.	13.
PM 172.2	122.	145.	.90	1.130	20.L	0.B	.98	.843	25.	0.B
PM 221.9	10.	190.	1.90	2.050	20.L	0.B	.90	1.270	18.	0.B

SAMPLE	Th* I O	Th* N O	Th* N G	Th* D G	Ti* X G	Ti* I1 G	Ti* I2 G	Ti* I O	Ti* N O	Tm* N O
19 268.5	10.	15.60	18.100	19.	[illegible]057.	3500.	0.B	2803.	2860.	1.L
19 327.8	7.	4.84	5.320	5.	959.	1200.	700.	471.	4000.L	1.L
19 337C	2.L	.63	.575	4.L	60.	300.	0.B	95.	1400.L	1.L
29 17.3	5.	4.78	4.480	14.L	599.	600.	300.	222.	510.	1.L
30 343.5	9.	21.60	22.600	24.	[illegible]815.	7100.	3800.	1791.	5400.	2.
30 348.5	6.	2.82	2.860	84.L	60.	200.	70.	48.	2000.L	2.L
32 47.5	10.	13.30	14.600	37.L	[illegible]017.	4700.	2900.	1015.	3600.	3.L
33 27.7	6.	15.60	17.900	22.	5156.	6500.	3300.	2447.	5100.	1.L
33 123.7	2.L	.58	.792	4.L	60.	70.	50.L	36.	760.L	0.L
38 51.5	13.	8.58	8.850	1600.L	[illegible]458.	3200.	2300.	2117.	5600.L	5.L
38 163C	2.	2.03	1.700	7.L	180.	300.	0.B	98.	4000.L	0.
38 193.8	3.	2.68	2.300	7.L	[illegible]017.	3400.	0.B	386.	4000.	2.L
55 138.2	8.	14.10	13.800	23.L	[illegible]455.	5000.	0.B	1913.	5500.	6.L
55 194.9	7.	7.00	6.740	18.	60.	100.	50.L	28.	1300.L	2.L
56 22C	17.	16.50	16.400	700.L	[illegible]098.	2300.	1600.	1134.	4300.	3.L
59 64.8	25.	45.60	46.700	54.	7254.	9200.	0.B	2809.	6500.	4.L
61 258C	4.	5.82	5.600	9.L	[illegible]858.	2000.	0.B	670.	1500.	1.L
64 103.0	2.L	1.07	1.070	7.L	1[illegible]0.	200.	0.B	72.	490.L	0.L
64 138.0	2.L	1.47	1.720	6.L	3[illegible]0.	700.	400.	203.	4900.L	1.L
64 151.4	11.	19.00	19.800	23.	[illegible]455.	10000.	3400.	3066.	4800.	2.L
64 194.0	19.	21.70	25.500	810.L	659.	700.	500.	407.	3600.L	5.L
65 92.8	127.	.00B	6.860	9900.L	[illegible]379.	1900.	1500.	1320.	23000.L	0.B
70 15.3	13.	6.50	7.790	990.L	[illegible]679.	1500.	0.B	929.	4000.L	5.L
70 26.4	30.	12.90	12.200	2500.L	1679.	2000.	1600.	1273.	5100.L	6.L
70 28.5	22.	5.47	11.900	1400.L	2818.	3300.	2300.	1596.	4700.L	2.L
70 112.0	8.	.67	.554	92.L	60.	70.	50.L	17.	1300.	1.L
70 113.0	18.	.50L	.760	2200.L	60.	50.	50.L	31.	6500.L	2.L
70 143.0	2.L	2.00L	2.100	5.	60.	80.	0.B	34.	1600.L	3.L
70 166.1	78.	.00B	37.400	3600.L	3177.	3700.	2600.	2227.	7100.L	0.B
73 44.1	7.	10.60	5.940	42.L	1259.	1000.	900.	553.	873.	11.L
73 47.6	2.L	6.50	8.790	12.L	5935.	6300.	0.B	2114.	5300.	1.L
73 103C	14.	20.60	20.200	870.L	6714.	10000.	4800.	3021.	4800.	3.L
73 178.3	56.	77.00	79.600	89.	3417.	4800.	2900.	2366.	2300.	2.L
78 145C	19.	21.60	21.200	1500.L	4796.	8300.	0.B	3035.	6000.L	10.L
79 106.0	67.	56.40	39.500	3700.L	3717.	4900.	3300.	2877.	9800.L	27.L
79 234.9	2.L	1.10	1.010	10.L	60.	200.	100.	93.	1800.L	1.L
80 36C	21.	14.20	10.100	1600.L	1978.	2400.	1700.	1101.	5000.L	3.
80 47.6	66.	11.70	11.500	5700.L	1259.	1200.	900.	720.	13000.L	28.L
80 54C	11.	17.20	18.100	390.L	2338.	2700.	0.B	1637.	1600.	3.L
80 68.2	18.	14.60	16.000	720.L	1199.	1300.	1800.	757.	3500.L	2.L
80 178C	2.L	5.07	3.780	14.L	719.	600.	0.B	122.	6000.L	2.L
81 72.4	9.	13.50	15.600	16.L	3537.	4500.	2800.	2532.	3500.	1.L
83 158.6	2.L	.86	1.010	7.L	60.	100.	0.B	15.	1200.L	2.
83 294.9	67.	.00B	12.700	4700.L	1978.	2700.	1700.	1628.	8100.L	0.B
83 516.8	15.	9.87	12.400	16.	2937.	2700.	0.B	1854.	2900.	1.L
97 67.1	2.L	4.03	3.710	13.L	1559.	1600.	900.	884.	1200.	2.L
97 86.6	13.	13.20	13.800	19.	3117.	3900.	0.B	1912.	2700.	2.L
97 90.2	28.	13.80	17.000	1100.L	5156.	6500.	5300.	3388.	7100.	3.L
PM 172.2	18.	24.80	25.400	27.	1319.	1300.	0.B	1030.	1300.	2.L
PM 221.9	19.	24.20	25.400	32.	3837.	6700.	0.B	2947.	3500.	2.L

Ranger Uranium Mine Duplicate Analyses - continued

SAMPLE	Tm* N G	V * I1 G	V * I2 G	V * I O	V * N O	Y * I1 G	Y * I2 G	Y * I O	Yb* I1 G	Yb* I2 G
19 268.5	.43	46.	0.B	46.	57.4	24.	0.B	16.	3.	0.B
19 327.8	.23	24.	25.	20.	25.3	16.	21.	16.	1.	1.
19 337C	.04	5.	0.B	4.	11.0L	2.L	0.B	2.	1.L	0.B
29 17.3	.28	51.	56.	52.	53.7	22.	23.	21.	1.	1.
30 343.5	.44	230.	200.	173.	198.0	10.	14.	7.	2.	2.
30 348.5	.11	3.	5.	4.	25.4	10.	9.	7.	1.L	1.L
32 47.5	.00B	240.	200.	162.	196.0	29.	31.	20.	2.	2.
33 27.7	.00B	120.	90.	81.	94.0	6.	7.	5.	1.	1.L
33 123.7	.07	2.L	2.L	2.L	12.0L	3.	4.	3.	1.L	1.L
38 51.5	.00B	200.	200.	173.	395.0	52.	61.	46.	7.	6.
38 163C	.15	4.	0.B	6.	48.0L	6.	0.B	11.	1.L	0.B
38 193.8	.00B	48.	0.B	42.	49.4	3.	0.B	2.	1.L	0.B
55 138.2	.70	140.	0.B	114.	138.0	34.	0.B	26.	3.	0.B
55 194.9	.00B	80.	65.	50.	62.8	3.	2.	1.	1.L	1.L
56 22C	.75	160.	170.	128.	239.0	28.	29.	19.	4.	3.
59 64.8	.00B	200.	0.B	139.	168.0	4.	0.B	1.L	2.	0.B
61 258C	.00B	46.	0.B	36.	48.6	5.	0.B	4.	1.L	0.B
64 103.0	.03	25.	0.B	28.	34.6	2.L	0.B	1.	1.L	0.B
64 138.0	.08	11.	11.	7.	47.0L	3.	5.	4.	1.L	1.L
64 151.4	.00B	210.	110.	118.	110.0	4.	5.	3.	2.	1.L
64 194.0	.58	170.	190.	151.	295.0	22.	27.	19.	3.	3.
65 92.8	.00B	66.	170.	120.	1380.0	260.	290.	229.	31.	27.
70 15.3	.36	130.	0.B	128.	340.0	28.	0.B	21.	3.	0.B
70 26.4	.00B	450.	470.	393.	699.0	35.	38.	29.	4.	3.
70 28.5	.48	280.	280.	231.	475.0	21.	24.	15.	3.	3.
70 112.0	.00B	45.	46.	41.	64.0	3.	3.	3.	1.L	1.L
70 113.0	1.30	130.	150.	123.	450.0	54.	53.	46.	7.	5.
70 143.0	.12	110.	0.B	77.	103.0	2.L	0.B	1.	1.L	0.B
70 166.1	.00B	380.	360.	294.	501.0	49.	63.	47.	10.	9.
73 44.1	.62	76.	100.	78.	103.0	46.	48.	32.	3.	3.
73 47.6	.17	180.	0.B	117.	130.0	4.	0.B	4.	1.L	0.B
73 103C	6.90	330.	230.	184.	335.0	29.	33.	21.	5.	4.
73 178.3	.42	16.	15.	16.	46.0L	24.	32.	22.	2.	2.
78 145C	.84	230.	0.B	131.	455.0	17.	0.B	27.	4.	0.B
79 106.0	.00B	410.	390.	323.	973.0	77.	85.	55.	9.	8.
79 234.9	.16	16.	16.	12.	13.3	7.	9.	6.	1.	1.
80 36C	.00B	210.	220.	174.	503.0	32.	36.	29.	4.	3.
80 47.6	3.51	74.	120.	76.	681.0	190.	210.	145.	18.	16.
80 54C	.43	110.	0.B	98.	155.0	17.	0.B	14.	3.	0.B
80 68.2	.36	96.	41.	94.	267.0	27.	24.	21.	3.	2.
80 178C	.19	18.	0.B	17.	42.0L	8.	0.B	10.	1.L	0.B
81 72.4	.28	180.	160.	145.	155.0	10.	12.	8.	2.	2.
83 158.6	.00B	100.	0.B	82.	86.1	2.	0.B	1.	1.L	0.B
83 294.9	2.50	150.	160.	138.	270.0	92.	100.	92.	12.	10.
83 516.8	.00B	48.	0.B	45.	57.9	5.	0.B	4.	1.	0.B
97 67.1	.71	31.	32.	28.	33.3	89.	95.	80.	4.	3.
97 86.6	.33	94.	0.B	79.	85.5	9.	0.B	3.	1.	0.B
97 90.2	.00B	240.	230.	186.	323.0	62.	69.	53.	4.	4.
PM 172.2	.45	19.	0.B	23.	28.3	14.	0.B	11.	2.	0.B
PM 221.9	.56	230.	0.B	135.	151.0	16.	0.B	14.	2.	0.B

Ranger Uranium Mine Duplicate Analyses - continued

SAMPLE	Yb* N O	Yb* N G	Zn* I1 G	Zn* I2 G	Zn* I O	Zn* N O	Zr* N O	Zr* N G	Lithtype	Preptype
19 268.5	1.40	2.610	50.	0.B	47.	21.L	230.L	190.	5	3
19 327.8	.88	1.200	20.L	20.L	4.	14.L	180.L	51.	8	3
19 337C	.15	.169	20.L	0.B	2.L	13.	100.L	13.L	7	1
29 17.3	.90	1.250	60.	70.	62.	110.L	120.L	74.L	9	2
30 343.5	1.00L	2.610	50.	50.	39.	94.L	0.B	246.	5	3
30 348.5	.50L	.608	20.	30.	48.	15.	14.L	0.B	5	3
32 47.5	.90	1.870	240.	180.	165.	100.L	1440.	99.	13	2
33 27.7	1.26	2.230	130.	90.	89.	40.L	260.	122.	10	2
33 123.7	.20L	.303	20.	20.	17.	19.L	86.L	26.	14	2
38 51.5	5.29	6.090	50.	60.	49.	60.L	42000.L	700.	5	2
38 163C	.93	.808	20.	0.B	7.	24.L	94.	42.L	8	1
38 193.8	.34L	.315	120.	0.B	89.	190.L	61.	100.	13	2
55 138.2	1.00L	3.650	20.	0.B	17.	100.L	0.B	205.	13	3
55 194.9	.30L	.180	70.	40.	33.	94.	0.L	20.L	3	3
56 22C	3.10	3.610	150.	150.	107.	60.L	14000.L	180.	5	1
59 64.8	.80	1.280	60.	0.B	47.	48.L	0.B	546.	2	2
61 258C	.48	.604	50.	0.B	37.	93.L	380.L	110.	12	1
64 103.0	.10L	.127	30.	0.B	27.	51.L	13.L	3.	9	3
64 138.0	.10L	.432	20.L	20.L	2.	6.L	120.L	33.L	8	2
64 151.4	1.00L	2.170	50.	20.	26.	26.L	320.L	150.	10	2
64 194.0	1.00L	2.520	120.	120.	100.	51.L	20000.L	0.B	11	3
65 92.8	.00B	29.900	70.	110.	58.	0.B	0.B	0.H	13	2
70 15.3	1.00L	2.580	70.	0.B	70.	100.L	30000.L	0.B	5	3
70 26.4	5.80	3.400	220.	210.	197.	360.	65000.L	0.H	5	2
70 28.5	1.00L	2.500	60.	50.	48.	66.L	6800.	0.B	5	3
70 112.0	.30L	.500	80.	70.	77.	130.L	4000.L	45.	3	2
70 113.0	1.30	4.600	110.	100.	82.	21.L	20000.L	0.B	3	2
70 143.0	.50L	.211	170.	0.B	106.	340.L	440.L	42.	3	3
70 166.1	.00B	9.160	230.	170.	169.	0.B	0.B	0.H	11	2
73 44.1	1.90	2.530	60.	90.	93.	100.L	1870.	230.L	13	2
73 47.6	.40L	1.000	70.	0.B	39.	57.L	550.	100.	10	3
73 103C	3.20	4.200	140.	90.	79.	787.	4100.L	200.	10	1
73 178.3	1.30	2.170	90.	70.	67.	120.L	526.	429.	14	2
78 145C	7.02	4.110	80.	0.B	36.	100.L	11000.L	0.B	10	1
79 106.0	6.00L	8.130	200.	160.	149.	200.L	1900.L	0.H	5	2
79 234.9	.42	.902	40.	20.	24.	76.L	32.	44.L	13	2
80 36C	4.30	2.980	170.	160.	134.	332.	8200.	100.	5	1
80 47.6	18.00	18.000	80.	80.	63.	200.L	2500.L	0.H	5	2
80 54C	.82L	2.260	60.	0.B	39.	42.L	2100.L	120.	5	1
80 68.2	1.60	2.700	40.	50.	43.	84.L	20000.L	0.B	9	3
80 178C	1.10	1.050	30.	0.B	15.	30.L	560.L	53.	8	1
81 72.4	.80	1.540	130.	120.	108.	269.	80.L	65.L	5	2
83 158.6	.31L	.128	80.	0.B	51.	150.L	180.L	17.	3	2
83 294.9	.00B	11.000	40.	110.	25.	0.B	0.B	0.H	9	2
83 516.8	.40	.750	60.	0.B	52.	100.L	47.	140.	8	2
97 67.1	2.33	3.170	30.	30.	36.	18.L	370.L	120.L	12	2
97 86.6	1.20	1.790	50.	0.B	48.	40.L	280.L	214.	2	2
97 90.2	2.20	3.830	170.	150.	132.	44.L	26000.L	620.	2	2
PM 172.2	2.08	2.700	20.L	0.B	22.	13.L	300.L	205.	4	2
PM 221.9	2.05	3.530	70.	0.B	41.	30.L	360.L	190.	4	2

Notes

Key to column headings:

Space 1 & 2 = element symbol.
Space 3 = analysis in percent (%) or in parts per million (*).
Space 5 & 6 = analytical method; X = XRF, I = ICP, N = INAA, D = delayed neutron.
1 = first replicate and 2 = second replicate by the same lab.
Space 8 = Laboratory, G = U. S. Geological Survey, : = Oak Ridge National Laboratory.

X-ray fluorescence analyses by J. S. Wahlberg, J. E. Taggart, and J. W. Baker, U. S. Geological Survey. Instrumental neutron activation and delayed neutron analyses by J. M. Storey, J. R. Budahn, R. J. Knight, S. E. Danahey, R. B. Vaughn, and M. Coughlin, U. S. Geological Survey and by the Nuclear Division of Oak Ridge National Laboratory. Induction coupled plasma spectrometry analyses by P. H. Briggs, U. S. Geological Survey and by the Nuclear Division, Oak Ridge National Laboratory.

XRF values for Mn, Na, P, and Ti have been converted from analyses reported as oxides in percent to elemental abundances in ppm in order to facilitate visual comparison with the values given by other analytical methods. XRF values for those elements are, however, accurate only to the nearest 0.01 percent (100 ppm).

Code "B" after a numerical value indicates that the element was not determined in that sample or that the value was deleted by the analysts. Code "L" means that the concentratin is less than the value indicated. Code "H" indicates that an analytical interference exists, the value is unreliable, and the sanalysis has been deleted by the author.

Key to "Lithtype" Lithologic Codes (*)

Code	Meaning
1	Diabase
2	Kombolgie Formation sandstone
3	Granitic dike
4	Hangingwall schist
5	Upper Mine schist
6	Carbonaceous schist
7	Lower Mine marble, unaltered
8	Lower Mine marble, chloritized
9	Lower Mine jasperoid
10	Lenticle schist
11	Shear zone rock
12	Massive chlorite rock or vein
13	Lower Mine chlorite-mica schist
14	Footwall gneiss and schist

* See Nash and Frishman (1982) for description of stratigraphy.

Key to "Preptype" Preparation codes

Code	Meaning
1	Samples prepared in Illinois Ave. Labs before January, 1981
2	Samples prepared in Ilinois Ave. Labs after January, 1981
3	Samples prepared in Ward Rd. Labs

Appendix II - Quality Control, U.S. Geological Survey INAA Laboratory.

Table A-1 is a summary of quality control data for the INAA analysis runs that generated the U.S. Geological Survey data presented in Appendix I. The sort of precision and accuracy represented by the data in table A-1 (i.e. average relative error of ±10 percent or less for most elements) may be expected for corresponding analyses of samples with a matrix similar (with respect to INAA) to the reference standards. In this case, "similar" can be considered to mean those samples with uranium abundances less than about 500 ppm.

Neutron induced fission of uranium results in a direct interference for the INAA measurement of La, Sm, Nd, Ce, and Zr. An numerical correction is used to correct for these interferences, but samples containing very high uranium abundances require a correction so large that the accuracy of the final result is greatly decreased. In addition, the special conditions of analysis required for these highly metalliferous samples may adversely affect the data quality in general.

An evaluation (in part subjective) of the data for the reference samples and of the relative disparity of analysis parameters required for those samples containing more than 500 ppm U suggests the following estimates of data quality:

1. The precision and accuracy of the data for samples having less than about 1000 ppm U are probably not significantly different from that indicated for the reference samples.

2. The relative accuracy of the data for samples containing between 1000 and 5000 ppm U is probably no better than ±20 percent and for K, Ba, La, Sm, Nd, and Ce may be as great as ±30 percent.

3. For samples containing more than 5000 ppm U, we cannot assess the quality of the data without examining the analytical results for representative reference samples.

Table A-1: Ratios of Accepted Value to Determined Value for U.S.G.S. INAA Runs 787, 790, 796, and 799. Accepted values for USGS standards BCR-1, G-2, and BHVO-1 can be found in Abbey (1983).

Element	787/BCR1	790/BCR1	790/G2	796/BCR1	796/BCR1	799/BHV01	Average & Standard Deviation	
Cs	.95	1.18	.88	.88	1.07	.97	.988	0.117
Rb	.99	1.04	1.04	1.14	1.12	1.22	1.092	0.084
Ba	1.05	.97	.99	1.02	.99	.89	.985	0.054
Sr	n. d.	.91	n. d.	.88	.88	.86	.883	0.026
K	n. d.	1.15	1.02	1.06	1.07	1.21	1.102	0.077
Na	.97	.99	.99	1.02	1.00	1.00	.995	0.016
Th	1.03	1.04	1.01	1.06	1.06	.91	1.018	0.056
U	.85	.80	.82	.79	1.02	.84	.853	0.085
La	.97	.98	1.00	1.04	1.01	1.05	1.008	0.032
Ce	.99	1.03	1.08	1.02	1.09	1.04	1.042	0.038
Nd	1.01	1.01	1.13	1.07	1.06	1.04	1.053	0.045
Sm	1.04	1.05	1.00	1.03	1.10	1.01	1.038	0.036
Eu	.98	1.05	1.02	1.01	1.03	1.07	1.027	0.031
Gd	1.30	1.02	1.17	1.09	1.09	.90	1.095	0.135
Tb	1.10	1.06	.91	1.04	1.05	1.07	1.038	0.066
Dy	1.02	.95	1.05	1.01	1.05	.96	1.007	0.043
Tm	n. d.	n. d.	n. d.	1.05	1.02	.95	1.067	0.051
Yb	1.12	1.06	1.15	1.06	1.03	1.14	1.093	0.050
Lu	.96	.95	n. d.	1.00	n. d.	1.04	.988	0.041
Ta	1.08	1.00	1.07	1.04	1.11	.98	1.047	0.050
Zr	n. d.	n. d.	1.09	n. d.	1.10	n. d.	1.095	0.007
Hf	.93	1.03	.98	1.06	1.07	.96	1.005	0.057
Sb	.93	1.16	1.62	1.10	1.11	1.05	1.162	0.238
Sc	.99	.99	1.00	.95	.94	1.08	.992	0.050
Mn	.98	1.01	.97	1.03	1.03	1.00	1.003	0.025
Fe	.99	.99	1.00	1.03	1.04	1.04	1.015	0.024
Cr	.87	1.06	1.01	.97	1.09	1.10	1.017	0.087
Co	.98	1.00	1.03	1.03	1.03	1.02	1.015	0.021

n. d. = not determined

Appendix III - Quality control, U.S. Geological Survey ICP Laboratory.

Table A-2 lists analyses for two reference standards analyzed along with the second set of Geological Survey ICP analyses (the "I2 G" analyses, Appendix I). As is the case with the INAA analyses, equivalent accuracy and precision can be expected for unknowns having a matrix similar to the reference standards. However, it should be realized that the necessity of dissolving the sample prior to ICP analysis can introduce some additional complications for certain samples.

Table A-2 : Chemical analyses of standard rocks GSP-1 and AVG-1 as determined by the USGS ICP lab on 29 August, 1983 (#), accepted values from Abbey, 1983 (*), and the ratio of accepted to determined value (A/D).

Element	GSP-1 #	GSP-1 *	A/D	AGV-1 #	AVG-1 *	A/D
Al %	8.00	8.10	1.01	9.40	9.10	.97
Ca %	1.50	1.45	.97	3.60	3.50	.97
Fe %	3.00	2.99	1.00	4.70	4.77	1.01
K %	4.50	4.57	1.02	2.50	2.42	.97
Mg %	.59	.59	1.00	.92	.92	1.00
Na %	2.10	2.08	.99	3.20	3.20	1.00
P %	.12	.12	1.00	.22	.22	1.00
Ti %	.35	.40	1.14	.60	.64	1.07
Mn ppm	300	310	1.03	730	774	1.06
Ag ppm	< 2	.08	- -	< 2	.09	- -
As ppm	<10	.09	- -	< 10	.80	- -
Au ppm	< 8	1 ppb	- -	< 8	.6 ppb	- -
Ba ppm	1300	1300	1.00	1200	1200	1.00
Be ppm	1	1	1.00	2	2	1.00
Bi ppm	< 1	.037	- -	< 10	.05	- -
Cd ppm	< 2	.06	- -	< 2	.09	- -
Ce ppm	380	360	.95	59	71	1.20
Co ppm	7	7.8	1.11	14	16.0	1.14
Cr ppm	12	12	1.00	9	10	1.11
Cu ppm	35	33	.94	59	59	1.00
Eu ppm	2	2.4	1.20	< 2	1.6	.00
Ga ppm	20	23	1.15	20	21	1.05
Ho ppm	< 4	n. d.	- -	< 4	.60	- -
La ppm	190	195	1.03	42	36	.86
Li ppm	28	30	1.07	12	12	1.00
Mo ppm	< 2	1.5	- -	< 2	3.0	- -
Nb ppm	23	23	1.00	17	16	.94
Nd ppm	200	190	.95	29	37	1.28
Ni ppm	9	9	1.00	17	15	.88
Pb ppm	53	54	1.02	35	33	.94
Sc ppm	7	6.6	.94	13	12.5	.96
Sn ppm	< 20	5.00	- -	< 20	3.60	- -
Sr ppm	230	240	1.04	670	660	.99
Ta ppm	< 40	1.00	- -	< 40	1.40	- -
Th ppm	100	105	1.05	4	6.4	1.60
U ppm	< 100	2.10	- -	< 100	1.95	- -
V ppm	53	54	1.02	130	125	.96
Y ppm	30	29	.97	21	19	.90
Yb ppm	2	1.9	.95	2	1.9	.95
Zn ppm	100	105	1.05	85	86	1.01

n. d. = not determined