

DEPARTMENT OF THE INTERIOR

U.S. GEOLOGICAL SURVEY

Geochemical Data for Unaltered Rocks and Uranium Ores
from the Cahill Formation, Northern Territory,
Australia

by

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This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards and stratigraphic nomenclature.

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Introduction

The purpose of this report is to make available the results of chemical analyses of samples from the Proterozoic Cahill Formation, Pine Creek Geosyncline, Northern Territory, Australia. In the Alligator Rivers region, the Cahill Formation hosts large, high-grade uranium and uranium-gold deposits that the U.S. Geological Survey began studying in 1980 as part of the National Uranium Resource Evaluation (NURE) program. Our investigations were intended to provide descriptions of two of these important deposits, Ranger and Jabiluka, and to generate deposit models that could be used as aids to exploration in the United States.

As part of our studies, we submitted approximately 700 rock samples from the Jabiluka and Ranger orebodies to U.S. Department of Energy (DOE) laboratories for trace element analyses. Subsequently, we resubmitted a subset of these samples to U.S. Geological Survey laboratories to verify the results of the original analyses and to obtain data on the rare-earth element (REE) abundances at Jabiluka and Ranger. We also submitted 10 samples from the Cahill Formation that were collected distant from known orebodies and were apparently unaffected by uranium mineralization. These 10 samples were analyzed to obtain background values for the elements of interest. This report tabulates the results, including REE data, for the samples of unmineralized Cahill Formation (Tables 1 and 2) and also lists analytical results for the samples from Ranger and Jabiluka analyzed by the Geological Survey (Tables 3 and 4). Nash and Frishman (1982) and Nutt and Grauch (1983) and the references contained therein provide geologic descriptions of the Ranger and Jabiluka orebodies. Nash and Frishman (1983) tabulate the first series of chemical analyses performed on the samples from Ranger (those run at the DOE labs) and provide some geochemical interpretations. Ewers (1982) and Ewers and Higgins (1985) present additional data and interpretations for an extensive suite of samples collected from holes drilled throughout the Pine Creek Geosyncline.

Sampling and Sample Descriptions

All samples from the Ranger and Jabiluka orebodies are from diamond drill core; they were collected by the authors and our partner in these studies, J. T. Nash. Sampling methodology and sample preparation methods are described by Nash and Frishman (1983). Samples from both Ranger and Jabiluka are identified by drillhole number and downhole depth in meters. Sample locations for the Ranger suite are listed in Nash and Frishman (1983) and drillhole locations are shown in Figure 2 of Nash and Frishman (1983) with the exception of the Ranger PMF-1 drillhole and the drillhole from Ranger 19. Drillhole PMF-1 is shown in Figure 2 of Nash and Frishman (1982), and the Ranger 19 drillhole is shown by Needham (1982b, 1984). The Jabiluka samples can be located on the cross sections shown by Nutt and Grauch (1983).

Samples of unmineralized Cahill Formation collected at localities remote from known orebodies were kindly provided by Stuart Needham of the Australian Bureau of Mineral Resources (BMR). Universal Transverse Mercator (UTM) grid references for the location of these drillholes are listed in the data tables; drillhole locations or the locations of stratigraphic drilling traverses are also shown by Needham (1984).

Analytical Techniques

All samples were analyzed by X-ray fluorescence spectroscopy (XRF), instrumental neutron activation analysis (INAA), and neutron activation-delayed neutron counting for uranium and thorium (DN). XRF analyses were performed on a Philips PW1600¹ wave length dispersive simultaneous X-ray spectrometer; analytical procedures are described by Taggart and others (1981). Loss on ignition (LOI) is determined from the weight loss of the 0.800 gram aliquot of powdered material used for the XRF fusion disc when it is fired in a muffle furnace at 925° C for 45 minutes. INAA procedures are modifications of those described by Gordon and others (1968) and are briefly described by McKown (in Frishman, 1984). The delayed neutron technique is described by Millard (1976). Many samples were also analyzed for fluorine (using a specific ion electrode) by a method similar to that described by Hopkins, 1977, for ferrous iron (by titration, Peck 1964), and for sulfur and carbon (by LECO¹ sulfur and carbon determinators, respectively; see Kirschenbaum, 1983 and Tillman, 1977).

The 10 samples from unmineralized portions of the Cahill Formation were also analyzed by emission spectrography for chalcophile elements plus phosphorus and gold using an emulsion specifically designed for use in the short-wavelength region (SWR) and by inductively coupled plasma spectroscopy (ICP). ICP analyses were done using a modified Jarrel-Ash 1160¹ direct reading spectrograph with an argon source. Taggart and others (1981) describe the analytical procedure and Crock and Lichte (1982) describe the in-house modifications made to the ICP hardware. SWR analyses were performed on a 3.4 m Ebert¹ spectrograph in a manner similar to that described by Heropoulos and others (1984).

Organization of Data Tables

Samples of unmineralized Cahill Formation (Tables 1 and 2) are simply listed in geographic order from south to north. Samples from Ranger are divided into groups by orebody (No.1 orebody, No.3 orebody, etc.) and each orebody is subdivided by stratigraphy, uppermost unit first, lowermost last. Within each stratigraphic subdivision, samples are listed by drillhole number in the same order as the drillholes were listed by Nash and Frishman (1983). Jabiluka samples are also sorted by orebody and stratigraphic unit, but within each stratigraphic unit the samples are listed geographically from west to east.

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

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Table 1
Geochemical data for unmineralized samples from the Cahill Formation

Sample ID	JJ64 71'0"	JJ63 87'0"	JJ7 93'8"	SN1 B	CA74 159'6"	CA67 146'0"	CA75 124'0"	CA66 171'0"	CA76 73121384 203'6"
Major elements in weight percent									
SiO ₂	42.60	60.10	66.50	1.43	72.80	71.60	69.30	73.40	30.00
Al ₂ O ₃	26.80	16.40	13.20	0.27	14.00	13.70	11.00	14.10	14.10
Fe ₂ O ₃	1.99	0.83	0.59	0.14	1.42	0.59	1.35	0.33	1.11
FeO	5.08	4.89	4.43	1.79	0.76	1.86	2.48	1.49	4.79
MgO	6.00	5.21	2.83	45.40	3.45	4.43	9.02	0.76	17.10
CaO	1.19	3.97	2.27	0.64	0.09	0.11	0.12	0.65	9.28
Na ₂ O	1.248	1.68	3.14	0.036	0.048	0.093	0.079	3.01	0.047
K ₂ O	6.92	2.96	2.50	<0.2	3.16	2.70	0.42	3.56	1.54
TiO ₂	0.83	0.40	0.43	0.02	0.25	0.47	0.20	0.18	0.53
P ₂ O ₅	0.16	0.05	0.16	0.00	0.02	0.11	0.03	0.03	0.05
MnO	0.059	0.044	0.132	0.182	0.020	0.025	0.051	0.183	0.159
LOI	5.44	1.78	2.72	50.20	3.46	3.61	5.04	1.43	20.30
Total	98.32	98.32	98.91	100.11	99.48	99.30	99.09	99.13	99.01
Minor and trace elements in ppm except as noted									
U	9.54	4.79	2.79	0.59	1.49	3.29	4.19	7.53	2.71
Th	28.1	12.1	18.4	<1.6	10.6	16.2	31.0	32.6	12.7
C-T%	0.69	0.18	0.32	13.3	0.02	<0.01	<0.01	0.03	3.75
S-T%	0.77	0.47	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
As	<1	<1	1	<1	3	1	1	<1	1.5
Ba	980	350	1700	7	210	210	62	1500	120
Be	2	2	2	<1	2	3	2	2	3
Bi	0.7	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cd	1.0	<0.2	<0.2	<0.2	<0.2	<0.2	0.3	<0.2	<0.2
Co	30.0	16.3	23.9	8.22	2.64	8.1	21.7	7.1	12.9
Cr	178	84.7	65.9	1.85	84.4	49.2	22.2	6.13	159
Cs	10.70	9.04	3.50	0.13	4.37	5.57	1.21	3.12	3.17
Cu	70	36	4	3	4	9	4	15	14
Ga	39	22	19	<4	14	18	20	21	20
Hf	5.57	1.57	6.02	0.10	3.86	4.31	4.56	4.92	2.99
Li	140	100	36	<2	46	97	520	25	120

Table 1 (Cont'd)
Chemical analyses of unmineralized samples from the Cahill Formation

Sample ID	JJ64 71'0"	JJ63 87'0"	JJ7 93'8"	SN1 B	CA74 159'6"	CA67 146'0"	CA75 124'0"	CA66 171'0"	CA76 203'6"	73121384
Minor and trace elements in ppm except as noted										
Nb	5	5	12	<4	5	10	10	6	14	7
Ni	90	39	27	4	8	29	78	8	51	<2
Pb	20	18	12	9	<4	7	7	42	6	6
Rb	309	147	133	0.64	82.5	92.3	31.7	115	76.3	<2.5
Sb	<.12	<0.06	0.08	0.02	0.196	<0.07	<0.05	<0.03	0.2	0.976
Sn	<4	<4	10	<4	5	<4	<4	6	<4	<4
Sr	88	190	160	5	16	17	6	150	13	44
Ta	1.97	0.686	1.16	0.013	0.475	0.973	1.02	0.971	0.928	0.0322
V	190	110	66	3	20	61	28	12	99	6
Y	13	9	26	<2	4	11	10	19	9	<2
Zn	>200	100	70	0.5	70	30	30	30	50	15
Zr	181	<71	229	<5.8	142	148	141	154	83.8	<9.3
Sc	21.9	13.6	9.8	0.296	4.05	12	4.27	4.8	14.8	0.429
La	49.7	35.2	88.1	0.504	15.8	37.3	2.42	39.4	25.4	1.03
Ce	74.2	62.2	169	1.62	30.1	70.8	5.00	81.2	47.4	1.84
Nd	34.9	27.3	64.9	1.00	12.6	30.5	3.0	35	20.9	0.9
Sm	5.82	4.27	10.8	0.276	1.74	5.49	1.14	6.30	3.61	0.203
Eu	1.07	0.875	1.88	0.073	0.315	0.552	0.218	0.766	0.73	0.045
Gd	n.r.	n.r.	7.56	0.30	1.16	4.6	n.r.	n.r.	2.1	0.24
Tb	0.530	0.435	1.09	0.041	0.211	0.675	0.350	0.822	n.r.	0.039
Dy	3.46	2.60	4.87	<6.2	1.59	4.3	2.6	5.11	1.7	0.25
Tm	0.270	0.197	0.420	0.0190	0.167	0.42	0.240	0.477	0.19	0.02
Yb	1.64	1.13	2.53	0.10	1.10	2.57	1.46	2.93	1.32	0.125
Lu	0.240	0.170	n.r.	0.0100	0.151	0.347	0.190	0.430	0.200	0.0160

Table 2
Lithology, location, analytical techniques, and references
for samples of unmineralized Cahill Formation

Sample Number	Lithology	UTM Grid Reference
JJ64- 71'0"	Carbonaceous biotite-muscovite-quartz schist	53LKF490595
JJ63- 87'0"	Pyrite-bearing feldspar-muscovite-quartz schist	53LKF490596
JJ 7- 93'8"	Quartz-feldspar-biotite schist	53LKF494588
SN1 B	Magnesite marble	53LKF689885
CA74-159'6"	Quartz-chlorite-sericite schist	53LKG740061
CA67-146'0"	Biotite-muscovite-quartz schist	53LKG740062
CA75-124'0"	Chloritized quartz-feldspar-biotite schist	53LKG741061
CA66-171'0"	Quartz-rich muscovite-feldspar-garnet schist	53LKG743060
CA76-203'6"	Chloritized dolomitic schist	53LKG743161
73121384	Calc-silicate	53LLG138217

Sample Number	References	Key to References
JJ64- 71'0"	1,2,6,7	1 = Australian Bureau of Mineral Resources, 1984
JJ63- 87'0"	1,2,6,7	
JJ 7- 93'8"	1,2,6,7	2 = Ewers, 1982
SN1 B	4,5	3 = Needham, 1982a
CA74-159'6"	2,4,5,6,7	4 = Needham, 1982b
CA67-146'0"	2,4,5,6,7	5 = Needham, 1984
CA75-124'0"	2,4,5,7,8	6 = Roarty, 1978
CA66-171'0"	2,4,5,7,8	7 = Stuart-Smith and Hone, 1975
CA76-203'6"	2,4,5,6,7	
73121384	3,5	8 = Wallace, 1980

n.r. = not reported

All samples are from the lower member of the Cahill Formation.

Eight of the samples are listed by drillhole number and depth in feet and inches. These samples are apparently equivalent to some of the samples analyzed by Ewers (1982). The other two are identified by a field number (SN1 B) and by an Australian Bureau of Mineral Resources analysis number (73121384).

Table 2 (Cont'd.)

Analytical Techniques

XRF	INAA	ICP	Analyzed but not detected in any samples at the detection limit shown.		
SiO ₂	Na La	Ba			
Al ₂ O ₃	Cs Ce	Ti			
Fe ₂ O ₃	Co Nd	Ni	Ag	2	ppm
MgO	Cr Sm	Be	Au	0.2	ppm
CaO	Hf Eu	Cu	Mo	2	ppm
K ₂ O	Mn Gd	Nb	Te	1	ppm
	Ta Tb	V	Se	5	ppm
SWR	Rb Dy	Pb	Hg	1	ppm
	Sb Tm	Sn			
As	Zr Yb	Sr			
Bi	Sc Lu	Y			
Cd		Ga			
Zn		Li			
P					

Other: LOI - Gravimetric
 FeO - Wet chemistry
 Fe⁺³ - Calculated from total Fe and FeO
 S & C - LECO analyzer
 U & Th - Delayed Neutron Analysis

Analysts

XRF: J. Taggart, Project Leader J. E. Taggart
 INAA & DN: J. Storey, J. Budahn, R. Knight, S. Danahey, R. B. Vaughn,
 M. Coughlin, Project Leader D.M. McKown.
 ICP: P. H. Briggs, Project Leader J. L. Seeley
 SWR: C. Heropoulos, Project Leader R. Mays.
 FeO, S, and C: G. Mason and V. Shaw, Project Leader L. L. Jackson

Table 3
Geochemical data for samples from Ranger and Jabiluka

RANGER					
Sample ID+	138-51.5	56-22C	70-15.3	70-26.4	70-28.5
Major Elements in Weight Percent					
SiO ₂	69.10	58.10	66.10	62.30	60.70
Al ₂ O ₃	12.90	13.30	10.50	12.70	15.90
Fe ₂ O ₃	3.02	9.73	4.62	5.20	3.99
FeO	n.a.	3.14	n.a.	n.a.	n.a.
Fe ₂ O ₃	n.a.	6.24	n.a.	n.a.	n.a.
MgO	4.80	10.60	9.09	9.52	9.73
CaO	0.06	0.12	1.00	0.23	0.13
Na ₂ O	0.051	0.032	0.028	0.033	0.085
K ₂ O	2.35	0.69	0.06	0.31	0.29
TiO ₂	0.41	0.35	0.28	0.28	0.47
P ₂ O ₅	0.05	0.13	0.84	0.21	0.13
MnO	0.012	0.016	0.010	0.017	0.009
F	n.a.	0.03	n.a.	n.a.	n.a.
LOI	5.31	6.77	7.01	7.92	7.43
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Total*	98.46	99.65	99.79	99.33	99.09
Minor and trace elements in ppm except as noted					
U	3890	1570	2340	5980	3220
Th	8.85	16.4	7.79	12.2	11.9
C-T%	n.a.	n.a.	n.a.	n.a.	0.03
S-T%	n.a.	n.a.	n.a.	n.a.	0.07
Ba	2400	600	300	3700	474
Co	25.1	30.7	30.6	26.8	19.0
Cr	110	67.3	60.6	133	71.5
Cs	6.34	1.41	0.54	1.03	0.82
Hf	2.00	4.51	2.09	4.8	3.87
Rb	143	38	<2.5	25	<2.5
Sb	2.84	0.59	0.819	2.62	0.71
Sr	<75	<75	<75	<75	<75
Ta	0.70	1.12	0.71	0.50	0.893
Zr	700	180	n.r.	n.r.	n.r.
Sc	19.4	18.0	9.67	13.9	17.8
La	23.3	8.19	14.9	31.1	10.4
Ce	135	30	37	265	33
Nd	100	25	33	n.r.	14
Sm	5.4	4.3	8	4.5	3.7
Eu	1.98	1.41	2.08	1.19	0.978
Gd	10.7	n.r.	8.8	6.2	7.2
Tb	1.72	1.28	1.47	1.35	0.986
Dy	n.r.	7.74	8.20	9.74	6.29
Tm	n.r.	0.75	0.36	n.r.	0.48
Yb	6.09	3.61	2.58	3.40	2.50
Lu	n.r.	n.r.	n.r.	n.r.	n.r.

Table 3 (Cont'd.)

Sample ID+	79-106.0	80-36C	80-47.6	80-54C	29-17.3
Major Elements in Weight Percent					
SiO ₂	44.90	62.20	70.10	68.50	80.50
Al ₂ O ₃	18.10	12.40	8.21	12.70	4.25
Fe ₂ O ₃	8.88	4.53	2.97	3.72	2.93
FeO	5.01	2.47	n.a.	2.18	n.a.
Fe ₂ O ₃	3.31	1.79	n.a.	1.30	n.a.
MgO	14.80	11.10	7.62	7.51	4.53
CaO	0.18	0.07	0.09	0.13	2.70
Na ₂ O	0.056	0.051	0.105	0.056	0.013
K ₂ O	0.41	0.52	0.86	1.76	0.01
TiO ₂	0.62	0.33	0.21	0.39	0.10
P ₂ O ₅	0.14	0.06	0.07	0.08	2.03
MnO	0.024	0.017	0.041	0.011	0.011
F	0.09	0.08	n.a.	0.06	n.a.
LOI	9.84	7.00	5.65	5.10	2.55
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Total*	99.31	98.56	98.68	99.88	99.63
Minor and trace elements in ppm except as noted					
U	12800	3760	20500	834	45.3
Th	39.5	10.1	11.5	18.1	4.48
C-T%	0.16	n.a.	n.a.	n.a.	n.a.
S-T%	0.12	n.a.	n.a.	n.a.	n.a.
Ba	12000	480	16000	299	54
Co	53.9	24.7	9.97	20.9	14.7
Cr	166	82.9	<140	32	33.1
Cs	1.09	1.24	4.01	3.02	0.043
Hf	3.36	2.19	56	4.32	0.529
Rb	25.6	32.0	55.5	88.9	<2.5
Sb	1.72	0.46	2.04	<0.42	0.0846
Sr	<75	n.r.	<75	<75	<75
Ta	1.90	<1	1.10	3.21	0.968
Zr	n.r.	100	n.r.	120	<74
Sc	31.7	16.6	35.5	10.7	3.77
La	91	16.3	189	6.46	5.42
Ce	570	55	689	24	4.43
Nd	n.r.	25	n.r.	11	7.29
Sm	18	7.1	48	3.1	2.67
Eu	4.52	2.02	14.1	0.665	0.774
Gd	25.0	8.21	74.3	3.9	4.45
Tb	4.09	1.55	12.5	0.69	0.822
Dy	25.0	9.37	66.3	4.63	4.36
Tm	n.r.	n.r.	3.51	0.43	0.28
Yb	8.13	2.98	18.0	2.26	1.25
Lu	n.r.	n.r.	n.r.	n.r.	0.18

Table 3 (Cont'd.)

Sample ID+	32-47.5	138-163C	138-193.8	55-138.2	55-194.9
Major Elements in Weight Percent					
SiO ₂	26.70	31.90	31.00	49.40	51.80
Al ₂ O ₃	20.70	1.02	19.30	17.90	19.70
Fe ₂ O ₃	13.40	1.74	10.40	2.64	3.22
FeO	9.31	1.33	n.a.	n.a.	n.a.
Fe ₂ O ₃	3.05	0.26	n.a.	n.a.	n.a.
MgO	19.10	33.10	26.30	6.81	14.90
CaO	5.44	0.85	0.13	7.10	0.20
Na ₂ O	0.017	0.046	0.011	0.023	0.148
K ₂ O	0.14	0.03	0.01	3.94	0.01
TiO ₂	0.67	0.03	0.67	0.91	0.01
P ₂ O ₅	4.07	0.06	0.10	5.21	0.13
MnO	0.043	0.115	0.019	0.006	0.010
F	n.a.	0.05	n.a.	n.a.	n.a.
LOI	10.20	30.30	11.70	5.43	8.26
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Total*	99.45	99.09	99.64	99.38	98.39
Minor and trace elements in ppm except as noted					
U	151	15.4	14.7	74.4	10.4
Th	14.6	1.70	2.30	13.8	6.74
C-T%	0.14	n.a.	n.a.	n.a.	0.06
S-T%	0.01	n.a.	n.a.	n.a.	0.01
Ba	<35	<35	<35	65	<35
Co	53.9	9.72	73.6	13.6	15.7
Cr	115	8.91	79.3	285	13.6
Cs	0.657	0.333	0.648	3.19	0.352
Hf	3.27	0.19	3.68	4.79	1.38
Rb	<2.5	<2.5	4.8	58.5	2.7
Sb	1.18	0.084	0.16	1.25	<0.037
Sr	<75	<75	<75	<75	<75
Ta	0.958	0.364	1.88	1.31	3.35
Zr	99.0	<42	99.8	205	<20
Sc	26.4	2.43	8.29	23.3	4.56
La	62.7	23.2	0.413	123	1.47
Ce	75.6	14	0.23	166	1.10
Nd	31.6	19.8	0.73	53.5	0.4
Sm	5.79	3.43	0.357	8.61	0.31
Eu	1.41	0.74	0.0906	2.01	0.0621
Gd	5.93	3.22	<0.74	9.31	n.r.
Tb	0.76	0.484	0.072	1.40	0.077
Dy	4.60	2.48	0.473	8.10	0.47
Tm	n.r.	0.154	n.r.	0.700	n.r.
Yb	1.87	0.808	0.315	3.65	0.18
Lu	0.285	n.r.	0.050	0.490	0.030

Table 3 (Cont'd.)

Sample ID+	64-103.0	64-138.0	165-92.8	70-112.0	70-113.0
Major Elements in Weight Percent					
SiO ₂	89.80	3.56	52.64	59.60	62.40
Al ₂ O ₃	3.22	1.85	12.55	14.50	11.70
Fe ₂ O ₃	1.81	2.90	6.24	8.26	7.49
FeO	n.a.	n.a.	n.a.	n.a.	4.65
Fe ₂ O ₃	n.a.	n.a.	n.a.	n.a.	2.32
MgO	3.53	26.30	12.18	10.20	9.69
CaO	0.06	21.20	0.35	0.32	0.40
Na ₂ O	0.017	0.069	0.162	0.065	0.106
K ₂ O	0.01	0.01	0.07	0.45	0.07
TiO ₂	0.02	0.06	0.23	0.01	0.01
P ₂ O ₅	0.02	0.06	0.16	0.24	0.30
MnO	0.005	0.310	0.084	0.018	0.022
F	n.a.	n.a.	n.a.	n.a.	0.06
LOI	1.81	43.80	7.84	6.17	5.61
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Total*	100.30	100.12	96.60	99.87	98.03
Minor and trace elements in ppm except as noted					
U	15.0	12.5	36900	408	7220
Th	1.07	1.72	6.86	0.55	0.76
C-T%	n.a.	n.a.	n.a.	n.a.	n.a.
S-T%	n.a.	n.a.	n.a.	n.a.	n.a.
Ba	35.7	37.0	31000	100	2200
Co	8.86	8.70	29.2	33.1	37.6
Cr	29.7	14.8	<270	0.69	<3.4
Cs	0.268	0.034	0.99	9.43	1.68
Hf	0.268	0.432	98	1.44	1.42
Rb	<2.5	<2.5	n.r.	81.8	<2.5
Sb	0.15	<0.037	18.6	0.24	5.3
Sr	<75	<75	<75	<75	<75
Ta	0.114	0.125	<1.1	3.41	5.34
Zr	3.4	<33	n.r.	45	n.r.
Sc	2.03	2.82	70	4.05	20.8
La	1.57	0.881	328	3.01	32.9
Ce	<2.3	2.2	1880	3.0	106
Nd	1.5	1.8	n.r.	n.r.	42
Sm	0.315	1.01	62.8	0.6	7.5
Eu	0.0746	0.292	30.1	0.145	2.48
Gd	0.40	1.39	109	n.r.	14.2
Tb	0.0659	0.221	20.2	0.138	3.49
Dy	0.372	<3.5	111	1.01	22.3
Tm	0.031	0.076	n.r.	n.r.	1.30
Yb	0.127	0.432	29.9	0.5	4.6
Lu	0.0200	0.0466	n.r.	n.r.	n.r.

Table 3 (Cont'd.)

Sample ID+	70-143.0	73-44.1	79-234.9	80-68.2	80-178C
Major Elements in Weight Percent					
SiO ₂	30.40	12.03	33.50	73.00	12.60
Al ₂ O ₃	23.80	7.91	18.90	10.60	3.72
Fe ₂ O ₃	12.50	34.83	5.27	3.56	3.45
FeO	n.a.	3.54	2.60	n.a.	n.a.
Fe ₂ O ₃	n.a.	30.90	2.38	n.a.	n.a.
MgO	21.30	9.45	26.40	6.72	38.20
CaO	0.49	17.53	1.41	0.07	1.72
Na ₂ O	0.012	0.016	0.030	0.015	0.025
K ₂ O	0.04	0.01	0.86	0.93	0.03
TiO ₂	0.01	0.21	0.01	0.20	0.12
P ₂ O ₅	0.36	13.12	1.00	0.06	0.06
MnO	0.022	0.011	0.029	0.009	0.207
F	n.a.	n.a.	n.a.	n.a.	n.a.
LOI	11.90	4.78	11.90	5.27	40.10
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Total*	100.83	99.52	99.02	100.63	100.24
Minor and trace elements in ppm except as noted					
U	3.74	178	20.8	1670	48.5
Th	2.10	5.94	1.01	16.0	3.78
C-T%	n.a.	0.16	0.17	0.20	n.a.
S-T%	n.a.	0.01	0.18	0.01	n.a.
Ba	<35	50	54.3	268	36.9
Co	57.7	33.8	29.9	20.4	16.4
Cr	8.79	90	2.65	45.1	29.4
Cs	0.884	<1.1	14	1.22	0.167
Hf	4.19	0.97	1.73	2.58	0.812
Rb	14.1	12	74.9	27	<2.5
Sb	0.197	0.81	0.0668	0.418	<0.040
Sr	<75	<75	<75	<75	<75
Ta	9.06	0.603	1.04	0.999	0.346
Zr	42	<230	<44	n.r.	53.3
Sc	11.5	12.3	2.21	10.7	4.94
La	0.405	19	1.72	17.1	22
Ce	1.00	34.4	4.87	42	16.5
Nd	n.r.	13	2.87	38	19.6
Sm	0.54	9.27	1.41	3.70	4.29
Eu	0.147	3.54	0.177	0.752	0.874
Gd	n.r.	13.3	1.6	5.7	3.37
Tb	0.15	1.81	0.27	0.972	0.501
Dy	0.563	8.77	1.65	6.17	2.51
Tm	0.12	0.619	0.159	0.36	0.19
Yb	0.211	2.53	0.902	2.7	1.05
Lu	0.024	0.410	n.r.	n.r.	0.160

Table 3 (Cont'd.)

Sample ID+	33-27.7	64-151.4	73-47.6	73-103C	78-145C
Major Elements in Weight Percent					
SiO ₂	57.00	59.40	63.50	37.30	58.60
Al ₂ O ₃	18.90	19.90	15.50	23.20	18.30
Fe ₂ O ₃	6.35	3.19	4.03	9.29	4.80
FeO	n.a.	2.98	n.a.	4.08	2.61
Fe ₂ O ₃	n.a.	-0.12	n.a.	4.76	1.90
MgO	8.55	7.37	7.40	15.80	7.38
CaO	0.07	0.05	0.27	0.24	0.06
Na ₂ O	0.243	0.189	0.148	0.162	0.944
K ₂ O	2.99	3.92	3.01	3.05	3.39
TiO ₂	0.86	0.91	0.99	1.12	0.80
P ₂ O ₅	0.07	0.02	0.24	0.05	0.05
MnO	0.027	0.007	0.007	0.019	0.012
F	n.a.	0.07	n.a.	0.12	0.11
LOI	5.60	5.36	4.96	9.32	5.24
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Total*	100.66	100.05	100.06	99.41	99.92
Minor and trace elements in ppm except as noted					
U	6.16	7.10	31.9	1970	3360
Th	17.9	19.8	8.79	20.2	21.2
C-T%	n.a.	n.a.	n.a.	n.a.	n.a.
S-T%	n.a.	n.a.	n.a.	n.a.	n.a.
Ba	279	323	188	550	960
Co	23.9	17.5	23.3	39.5	25.5
Cr	226	173	520	203	163
Cs	1.54	3.36	3.38	2.06	17.4
Hf	4.06	4.51	4.02	4.74	3.86
Rb	68.9	87.5	75.4	70.1	174
Sb	0.214	<0.084	0.372	0.370	0.861
Sr	<75	<75	<75	<75	<75
Ta	1.52	1.71	0.724	2.71	4.73
Zr	122	150	100	200	n.r.
Sc	15.3	19.6	19.8	25.7	21.7
La	18.0	7.96	49.5	10.4	16.4
Ce	28.0	14.0	52.4	59.0	58.0
Nd	15.1	5.98	13.0	35.0	33.0
Sm	2.48	1.55	2.07	8.60	10.0
Eu	0.561	0.492	0.549	1.74	2.46
Gd	n.r.	n.r.	n.r.	9.54	12.4
Tb	0.532	0.353	0.319	1.61	1.78
Dy	3.40	2.32	2.00	9.70	11.10
Tm	n.r.	n.r.	0.174	6.9	0.835
Yb	2.23	2.17	1.00	4.20	4.11
Lu	0.370	0.370	0.157	n.r.	n.r.

Table 3 (Cont'd.)

Sample ID+	161-258C	64-194.0	70-166.1	33-123.7	73-178.3
Major Elements in Weight Percent					
SiO ₂	53.80	54.10	29.00	72.20	68.40
Al ₂ O ₃	14.00	13.00	20.40	14.90	14.60
Fe ₂ O ₃	3.52	7.53	10.60	1.60	3.22
FeO	n.a.	n.a.	5.84	n.a.	n.a.
Fe ₂ O ₃	n.a.	n.a.	4.11	n.a.	n.a.
MgO	17.50	17.20	22.50	1.69	3.75
CaO	0.99	0.43	0.57	0.18	0.38
Na ₂ O	0.045	0.036	0.051	0.175	0.095
K ₂ O	0.03	0.01	0.02	6.44	4.85
TiO ₂	0.31	0.11	0.53	0.01	0.57
P ₂ O ₅	0.37	0.29	0.39	0.17	0.31
MnO	0.024	0.019	0.034	0.018	0.033
F	n.a.	n.a.	0.14	n.a.	n.a.
LOI	8.40	7.94	12.80	2.39	3.57
Total*	98.99	100.88	97.77	99.77	99.78
Minor and trace elements in ppm except as noted					
U	25.0	1900	12700	3.03	8.85
Th	5.60	25.5	37.4	0.79	79.6
C-T%	n.a.	0.03	n.a.	n.a.	n.a.
S-T%	n.a.	0.12	n.a.	n.a.	n.a.
Ba	<35	380	12000	468	501
Co	21.6	36	54	1.85	5.66
Cr	49.6	51.6	151	1.07	6.59
Cs	1.31	0.4	0.68	3.65	5.00
Hf	3.58	1.01	3.5	1.02	12.0
Rb	3.95	<2.5	<2.5	152	155
Sb	0.153	0.91	4.52	0.104	0.071
Sr	<75	<75	<75	<75	<75
Ta	4.82	2.68	5.2	0.195	1.15
Zr	110	n.r.	n.r.	26.4	429
Sc	3.15	8.37	44.7	0.647	4.44
La	2.33	8.28	83.8	1.03	92.8
Ce	3.5	32	381	2.31	215
Nd	2.5	48	n.r.	n.r.	92.1
Sm	1.0	12.9	29.6	0.553	17
Eu	0.139	2.25	9.93	0.173	0.578
Gd	1.39	15	35.7	0.8	13.5
Tb	0.264	1.83	6.93	0.177	1.63
Dy	1.45	9.3	33.1	0.915	7.35
Tm	n.r.	0.58	n.r.	0.067	0.42
Yb	0.604	2.52	9.16	0.303	2.17
Lu	<0.46	n.r.	n.r.	0.043	n.r.

Table 3 (Cont'd.)

Sample ID+	59-64.8	97-86.6	97-90.2	83-158.6	81-72.4
Major Elements in Weight Percent					
SiO ₂	32.20	65.20	36.70	58.40	60.40
Al ₂ O ₃	22.90	14.30	18.00	15.50	15.40
Fe ₂ O ₃	11.00	2.89	7.26	6.67	7.67
FeO	n.a.	1.70	n.a.	n.a.	n.a.
Fe ₂ O ₃	n.a.	1.00	n.a.	n.a.	n.a.
MgO	19.70	8.27	15.10	11.80	7.12
CaO	0.01	0.01	6.15	0.33	0.14
Na ₂ O	0.058	0.033	0.053	0.093	0.028
K ₂ O	1.86	2.52	1.33	0.72	2.72
TiO ₂	1.21	0.52	0.86	0.01	0.59
P ₂ O ₅	0.19	0.10	4.49	0.24	0.11
MnO	0.016	0.010	0.021	0.029	0.052
F	n.a.	0.06	n.a.	n.a.	n.a.
LOI	10.20	5.48	9.35	6.19	5.99
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Total*	99.34	99.21	99.58	99.98	100.22
Minor and trace elements in ppm except as noted					
U	3.5	14.5	2630	11.4	47.9
Th	46.7	13.8	17.0	1.01	15.6
C-T%	n.a.	n.a.	n.a.	n.a.	n.a.
S-T%	n.a.	n.a.	n.a.	n.a.	n.a.
Ba	150	137	2100	<35	110
Co	62.3	15.4	79.3	30.9	15.6
Cr	130	132	336	18.2	194
Cs	1.51	2.19	2.14	1.85	14.4
Hf	16.8	5.9	4.79	1.93	3.41
Rb	45.4	45.6	34.3	22.7	195
Sb	1.77	0.315	1.38	0.108	0.174
Sr	167	<75	<75	<75	<75
Ta	1.90	0.98	1.5	9.26	1.09
Zr	546	214	620	17	<65
Sc	15.2	12.9	18.7	6.87	16.0
La	495	257	44.3	13.8	1.26
Ce	663	282	144	15.4	1.44
Nd	170	70.1	82	2.97	n.r.
Sm	12.9	4.96	8.31	0.60	0.79
Eu	1.63	0.924	2.51	0.103	0.266
Gd	n.r.	n.r.	14	n.r.	n.r.
Tb	0.215	0.530	2.05	0.102	0.317
Dy	0.812	3.25	8.18	0.48	2.30
Tm	n.r.	0.33	n.r.	n.r.	0.28
Yb	1.28	1.79	3.83	0.128	1.54
Lu	0.180	0.240	n.r.	0.023	0.022

Table 3 (Cont'd.)

Sample ID+	130-343.5	130-348.5	97-67.1	83-294.9	83-516.8
Major Elements in Weight Percent					
SiO ₂	44.10	86.90	55.30	59.00	34.90
Al ₂ O ₃	20.40	1.24	5.05	11.00	13.50
FeT ₀₃	9.27	4.72	2.10	4.15	2.42
FeO	n.a.	n.a.	n.a.	2.51	n.a.
Fe ₂ O ₃	n.a.	n.a.	n.a.	1.36	n.a.
MgO	9.04	0.87	6.98	12.70	24.50
CaO	0.25	0.04	15.40	0.62	6.89
Na ₂ O	0.048	0.029	0.012	0.216	0.148
K ₂ O	4.25	0.01	0.01	0.08	1.60
TiO ₂	0.97	0.01	0.26	0.33	0.49
P ₂ O ₅	0.18	0.02	11.50	0.10	0.02
MnO	0.012	0.003	0.008	0.024	0.021
F	n.a.	n.a.	n.a.	0.07	n.a.
LOI	11.50	2.96	3.19	7.52	14.80
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Total*	100.02	96.84	99.81	97.31	99.29
Minor and trace elements in ppm except as noted					
U	16.2	368	41.0	16500	4.59
Th	22.6	2.86	3.71	12.7	12.4
C-T%	3.23	0.22	n.a.	n.a.	n.a.
S-T%	3.58	3.46	n.a.	n.a.	n.a.
Ba	253	130	53	3500	89.7
Co	73.8	11.1	12.0	39.1	5.77
Cr	182	5.54	96.9	52.1	71.4
Cs	8.43	1.11	1.05	1.48	6.25
Hf	5.37	0.042	0.927	49	4.72
Rb	240	<2.5	2.6	<2.5	47.6
Sb	3.27	4.38	0.348	1.42	0.106
Sr	<75	<75	<75	<75	<75
Ta	1.59	0.025	0.228	1.4	0.742
Zr	246	n.r.	<120	n.r.	140
Sc	21.0	0.815	7.71	29.9	7.2
La	37.1	1.55	53.5	144	8.16
Ce	66.4	4.0	70.6	396	20.4
Nd	27.7	3.0	29.6	n.r.	9.89
Sm	5.11	0.80	6.63	<16	1.95
Eu	0.646	0.169	1.92	3.49	0.336
Gd	4.55	1.49	8.99	n.r.	n.r.
Tb	0.654	0.270	1.42	4.74	0.169
Dy	4.13	1.73	8.27	35.1	1.17
Tm	0.437	0.107	0.709	2.5	n.r.
Yb	2.61	0.608	3.17	11	0.75
Lu	0.380	n.r.	n.r.	n.r.	<0.088

Table 3 (Cont'd.)

Sample ID+	PMF1-172.2	PMF1-221.9	19-268.5	19-327.8	19-337C
Major Elements in Weight Percent					
SiO ₂	72.60	59.40	66.20	17.60	5.93
Al ₂ O ₃	13.60	18.80	15.70	5.50	0.84
Fe ₂ O ₃	2.32	4.09	4.41	2.09	0.50
FeO	1.85	2.83	n.a.	n.a.	n.a.
Fe ₂ O ₃	0.26	0.95	n.a.	n.a.	n.a.
MgO	0.72	5.35	2.13	17.80	20.80
CaO	0.70	0.83	3.72	21.20	28.20
Na ₂ O	2.022	0.086	2.871	0.059	0.022
K ₂ O	6.24	4.49	3.72	1.32	0.14
TiO ₂	0.22	0.64	0.51	0.16	0.01
P ₂ O ₅	0.06	0.30	0.12	0.02	0.02
MnO	0.033	0.085	0.061	0.129	0.064
F	0.03	0.12	n.a.	n.a.	n.a.
LOI	1.12	5.04	0.93	33.90	42.90
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Total*	99.46	98.92	100.37	99.78	99.43
Minor and trace elements in ppm except as noted					
U	7.2	13.6	4.98	1.40	3.83
Th	25.4	25.4	18.1	5.32	0.58
C-T%	n.a.	n.a.	n.a.	8.68	n.a.
S-T%	n.a.	n.a.	n.a.	0.01	n.a.
Ba	1290	355	949	104	<35
Co	3.52	6.32	10.50	5.84	1.58
Cr	11.0	113	55.5	32.2	4.04
Cs	2.67	9.53	4.67	2.20-	0.359
Hf	6.17	4.93	5.73	1.06	0.19
Rb	169	223	131	31.2	3.4
Sb	0.13	0.279	0.11	0.0788	<0.026
Sr	145	190	356	<75	<75
Ta	1.13	2.05	0.942	0.373	0.055
Zr	205	190	190	50.7	<13
Sc	5.23	16.00	12.20	4.64	0.749
La	53.1	77.5	48.0	42.9	1.74
Ce	108	152	92.9	34.8	2.93
Nd	40.9	57.7	37.8	31.6	1.6
Sm	7.09	10.70	6.67	5.07	0.366
Eu	0.846	1.09	1.28	0.967	0.086
Gd	n.r.	9.83	6.17	3.88	0.408
Tb	0.843	1.27	0.812	0.486	0.061
Dy	4.35	7.00	5.00	2.90	<1.4
Tm	0.451	0.558	0.430	0.230	0.042
Yb	2.70	3.53	2.61	1.20	0.169
Lu	0.392	0.520	0.400	0.163	n.r.

Table 3 (Cont'd.)

JABILUKA

Sample ID+	Y069V 39.3	Y069V 73.5	AN048V 31.2	GN042V 119.8	GN042V 110.2
Major Elements in Weight Percent					
SiO ₂	68.50	52.10	54.00	48.90	62.00
Al ₂ O ₃	13.40	14.00	15.40	14.80	16.20
Fe ₂ O ₃	3.19	4.74	5.27	11.40	9.91
FeO	2.34	2.77	1.92	8.59	7.75
Fe ₂ O ₃	0.60	1.66	3.14	1.85	1.30
MgO	7.02	17.10	7.50	9.04	3.85
CaO	0.12	0.54	0.13	9.93	0.49
Na ₂ O	0.032	0.019	0.064	0.080	1.099
K ₂ O	1.73	<.02	2.36	2.04	2.56
TiO ₂	0.53	0.49	0.58	0.80	0.71
P ₂ O ₅	0.09	0.38	0.09	0.09	0.18
MnO	0.027	0.015	0.021	1.189	0.179
F	0.06	0.13	0.10	0.01	0.06
LOI	5.07	10.40	14.10	1.32	3.60
Total*	99.52	99.65	99.43	98.64	99.98
Minor and trace elements in ppm except as noted					
U	5.00	407	203	0.43	5.21
Th	17.8	13	20.4	17.9	1.2
S-T%	n.a.	0.298	n.a.	0.941	0.017
C-T%	0.009	2.233	6.639	0.039	0.019
Ba	<100	<100	142	406	128
Co	8.6	19.1	24.4	26.8	48.7
Cr	53.5	124	74.6	107	437
Cs	3.53	0.639	4.13	2.29	0.27
Hf	7.03	3.32	4.20	3.33	1.24
Rb	68	<10	80.7	110	26.7
Sb	0.033	0.239	0.584	<0.086	<0.17
Sr	<100	<100	<100	<100	<100
Ta	1.00	0.867	1.35	2.41	0.175
Zr	243	180	<290	104	<100
Sc	9.97	9.41	23.4	18.5	39.0
La	47.4	10.3	28.7	38.2	5.48
Ce	91.2	10.8	41.2	81.0	10.3
Nd	36.1	12.3	18.0	30.4	7.42
Sm	6.75	2.84	3.14	5.86	1.93
Eu	0.763	0.733	0.395	1.15	0.705
Gd	4.84	3.31	n.r.	5.40	2.32
Tb	0.780	0.586	0.748	0.870	0.405
Dy	4.06	3.31	4.53	n.r.	<3.0
Tm	0.36	0.19	0.478	0.483	0.28
Yb	2.39	1.19	3.09	2.94	1.83
Lu	0.337	n.r.	0.458	n.r.	0.295

Table 3 (Cont'd.)

Sample ID+	X102V 121.7	X102V 143.0	T147V 54.0	O162ND 41.1	O162ND 143.2
Major Elements in Weight Percent					
SiO ₂	70.60	65.60	90.50	90.90	30.10
Al ₂ O ₃	2.53	17.40	4.76	4.09	23.60
Fe ₂ O ₃	4.49	2.84	0.87	1.90	12.20
FeO	2.00	1.66	0.53	0.22	7.56
Fe ₂ O ₃	2.27	1.00	0.28	1.66	3.80
MgO	6.56	4.90	1.10	0.52	19.50
CaO	4.81	0.10	<.02	<.02	0.04
Na ₂ O	0.011	0.166	0.012	0.010	0.018
K ₂ O	<.02	4.07	1.15	1.02	<.02
TiO ₂	0.06	0.50	0.07	0.11	1.33
P ₂ O ₅	<.05	0.09	<.05	<.05	0.19
MnO	0.087	0.011	0.004	0.003	0.031
F	0.04	0.08	0.01	<.01	0.16
LOI	8.07	4.65	1.13	0.81	12.50
Total*	97.05	100.23	99.55	99.34	98.83
Minor and trace elements in ppm except as noted					
U	102	4.57	1.13	1.18	6.96
Th	3.35	20.8	4.83	9.13	142
S-T%	1.792	0.019	0.009	n.a.	n.a.
C-T%	0.707	0.059	0.018	0.009	0.019
Ba	<100	509	<100	<100	<100
Co	8.61	9.96	1.28	0.851	72.8
Cr	12.0	80.0	2.19	3.88	35.1
Cs	0.105	4.15	0.251	0.246	0.327
Hf	0.666	4.79	3.03	3.58	36.4
Rb	<10.	130	13.8	12.7	<10
Sb	0.20	<0.18	0.128	0.184	0.554
Sr	<100	<100	<100	<100	120
Ta	0.213	1.25	0.259	0.395	6.90
Zr	<460.	234	96.6	118	1120
Sc	7.03	17.0	0.874	0.781	6.68
La	1.5	51.1	17.7	17.7	429
Ce	4.89	101	32.3	29.4	712
Nd	3.42	44.0	13.2	13.0	205
Sm	0.913	8.17	1.70	1.78	17.8
Eu	0.372	1.42	0.358	0.347	1.78
Gd	1.4	6.50	n.r.	n.r.	n.r.
Tb	0.258	1.08	0.0776	0.127	0.523
Dy	1.64	5.83	0.45	0.615	3.66
Tm	0.132	0.510	0.034	n.r.	n.r.
Yb	0.772	3.15	0.323	0.311	3.11
Lu	0.114	0.440	0.049	0.0393	0.520

Table 3 (Cont'd.)

Sample ID+	S177V	S189V	N204V	N204V	0162ND
	137.6	153.7	246.7	264.5	150.5
Major Elements in Weight Percent					
SiO ₂	87.00	94.00	51.20	68.90	60.80
Al ₂ O ₃	7.19	0.97	13.30	16.80	21.10
Fe ₂ O ₃	1.39	2.87	3.03	1.21	1.94
FeO	0.17	0.35	1.78	0.47	0.90
Fe ₂ O ₃	1.20	2.48	1.05	0.69	0.94
MgO	0.44	0.47	22.10	3.01	4.77
CaO	<.02	<.02	0.02	0.28	<.02
Na ₂ O	0.018	0.007	0.021	0.072	0.101
K ₂ O	1.96	<.02	<.02	4.98	4.80
TiO ₂	0.17	<.02	0.39	0.64	0.52
P ₂ O ₅	<.05	<.05	<.05	0.22	<.05
MnO	0.003	0.013	0.008	0.004	0.010
F	0.01	<.01	0.17	0.07	0.07
LOI	1.34	0.65	9.30	3.48	5.12
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Total*	99.50	98.94	99.34	99.62	99.14
Minor and trace elements in ppm except as noted					
U	1.56	1.15	4.18	8.39	43.9
Th	15.8	2.72	36.8	20.7	27.8
S-T%	n.a.	0.009	n.a.	n.a.	n.a.
C-T%	0.043	0.034	n.a.	0.013	0.073
Ba	<100	<100	<100	310	421
Co	0.633	1.79	29.5	4.11	7.80
Cr	4.53	4.67	21.3	194	48.6
Cs	0.745	0.0731	0.324	2.63	3.70
Hf	4.28	1.2	16.2	6.67	6.17
Rb	24.2	<10	<10	113	169
Sb	0.308	0.619	0.155	0.189	0.099
Sr	<100	<100	<100	<100	<100
Ta	0.749	0.0747	1.33	1.23	1.77
Zr	140	36	502	222	<530
Sc	1.31	0.478	5.69	14.0	15.1
La	33.4	8.50	1.35	39.6	61.8
Ce	48.9	14.8	3.33	76.4	101
Nd	17.9	4.74	2.80	32.6	36.4
Sm	2.16	0.814	1.01	6.27	4.32
Eu	0.381	0.0954	0.253	1.17	0.456
Gd	n.r.	0.54	n.r.	5.63	n.r.
Tb	0.103	0.0527	0.438	0.872	0.382
Dy	0.670	0.29	2.96	5.05	2.72
Tm	n.r.	0.0343	0.425	0.533	0.330
Yb	0.359	0.174	2.55	3.14	1.95
Lu	0.0660	0.0293	0.375	0.458	0.300

Table 3 (Cont'd.)

Sample ID+	V111V	V123V	T129V	T141V	O162ND
	50.0	76.7	90.8	100.4	159.6
Major Elements in Weight Percent					
SiO ₂	70.10	81.10	58.20	68.90	61.70
Al ₂ O ₃	11.30	5.57	13.60	7.78	14.00
Fe ₂ O ₃	4.52	1.66	4.59	1.84	3.16
FeO	1.93	1.00	2.14	1.24	1.02
Fe ₂ O ₃	2.38	0.55	2.21	0.46	2.03
MgO	1.75	7.05	7.74	7.86	3.78
CaO	<.02	0.66	0.09	2.87	0.27
Na ₂ O	0.064	0.015	0.073	0.020	0.084
K ₂ O	2.93	<.02	2.44	0.60	3.45
TiO ₂	0.41	0.13	0.50	0.33	0.48
P ₂ O ₅	<.05	0.49	0.08	0.40	0.22
MnO	0.022	0.011	0.011	0.030	0.008
F	0.04	0.09	0.08	0.12	0.09
LOI	8.74	3.55	12.50	8.28	12.50
<hr/>					
Total*	99.67	100.32	99.67	98.89	99.63
Minor and trace elements in ppm except as noted					
U	19.4	909	40.9	13.0	19.7
Th	13.6	4.94	17.8	10.3	16.9
S-T%	n.a.	n.a.	n.a.	n.a.	n.a.
C-T%	n.a.	n.a.	n.a.	n.a.	8.458
Ba	177	200	208	<100	248
Co	14.8	8.15	32.3	30.0	11.9
Cr	47.5	24.6	55.0	69.9	62.4
Cs	2.36	<0.054	2.92	0.921	4.26
Hf	3.34	0.88	5.12	2.38	3.95
Rb	80.2	<10.	76.8	24.5	99.0
Sb	0.251	0.194	0.282	0.120	0.118
Sr	<100	<100	<100	<100	<100
Ta	0.911	0.270	1.44	0.779	1.30
Zr	126	3300	<370	120	131
Sc	9.49	2.75	13.3	6.98	14.4
La	28.9	2.2	35.3	42.2	58.2
Ce	49.0	12.4	62.7	59.3	93.3
Nd	15.9	n.r.	23.7	17.5	32.9
Sm	2.39	3.59	5.04	2.32	5.09
Eu	0.385	0.917	0.525	0.429	0.626
Gd	n.r.	4.60	4.41	n.r.	n.r.
Tb	0.434	0.720	0.833	0.364	0.803
Dy	3.38	4.08	4.85	2.20	4.95
Tm	0.39	0.235	0.557	0.222	0.613
Yb	2.54	1.10	3.28	1.23	3.37
Lu	0.420	<0.029	0.510	0.180	0.510

Table 3 (Cont'd.)

Sample ID+	T129V 149.0A	T129V 149.0B	T147V 118.0	0162ND 207.0	0162ND 214.3
Major Elements in Weight Percent					
SiO2	63.90	74.30	98.40	73.20	73.90
Al2O3	13.30	12.90	0.85	13.40	11.20
Fe2O3	4.24	1.23	0.07	1.02	1.27
FeO	2.85	0.74	0.08	0.59	0.66
Fe2O3	1.07	0.41	-0.02	0.36	0.54
MgO	11.60	5.05	<.10	5.69	6.83
CaO	0.06	0.03	<.02	0.05	0.12
Na2O	0.017	0.039	0.021	0.039	0.053
K2O	0.19	1.80	<.02	1.42	1.15
TiO2	0.24	0.21	<.02	0.22	0.43
P2O5	<.05	<.05	<.05	<.05	0.08
MnO	0.017	0.011	0.001	0.004	0.009
F	0.06	0.05	<.01	0.05	0.04
LOI	6.62	4.34	0.44	4.84	4.54
Total*	99.95	99.88	99.77	99.86	99.65
Minor and trace elements in ppm except as noted					
U	183	18.4	<0.28	10.9	879
Th	28.6	30.3	<0.10	29.9	15.7
S-T%	n.a.	n.a.	n.a.	n.a.	n.a.
C-T%	n.a.	0.019	n.a.	0.023	0.029
Ba	<100	<100	<100	<100.	440
Co	16.9	3.43	0.0333	4.57	8.05
Cr	9.75	6.21	0.373	7.13	37.4
Cs	0.599	2.07	0.0303	1.72	0.945
Hf	8.08	7.41	0.0116	7.85	4.74
Rb	<10	42.6	<10	37.1	28
Sb	0.085	0.102	0.16	0.0495	0.33
Sr	<100	<100	<100	<100	<75
Ta	1.70	1.57	0.0167	1.67	0.855
Zr	900	227	1	232	140
Sc	7.09	5.19	0.0275	5.56	10.3
La	6.79	62.5	0.16	28.0	14.5
Ce	13.1	123	0.293	50.6	45.0
Nd	8.17	48.8	0.11	21.4	27
Sm	1.83	9.28	0.020	3.92	5.6
Eu	0.306	0.369	0.00398	0.195	0.740
Gd	n.r.	7.78	n.r.	n.r.	6.9
Tb	0.677	1.18	0.0042	0.775	1.15
Dy	5.01	6.55	<0.33	5.31	7.15
Tm	n.r.	0.643	n.r.	0.605	n.r.
Yb	3.69	4.14	0.0117	4.02	3.84
Lu	0.530	0.580	0.00126	0.600	<0.16

Table 3 (Cont'd.)

Sample ID+	S177V	S177V	S177V	S189V	N204V
	156.5	186.7	226.0	188.5	311.4
Major Elements in Weight Percent					
SiO ₂	53.90	71.70	70.20	41.20	68.20
Al ₂ O ₃	23.20	14.00	14.70	29.40	15.80
Fe ₂ O ₃	4.78	2.26	1.43	5.05	3.41
FeO	1.54	1.52	0.74	2.71	2.35
Fe ₂ O ₃	3.07	0.57	0.61	2.04	0.80
MgO	6.27	3.65	5.85	7.24	4.17
CaO	0.14	0.14	0.11	0.49	0.06
Na ₂ O	0.150	0.028	0.072	0.350	0.156
K ₂ O	5.12	3.16	1.65	7.06	3.66
TiO ₂	0.66	0.57	<.02	0.86	0.37
P ₂ O ₅	0.11	0.09	0.06	0.15	0.06
MnO	0.016	0.025	0.008	0.051	0.007
F	0.07	0.06	0.06	0.10	0.07
LOI	3.75	4.07	5.26	7.39	3.45
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Total*	98.00	99.58	99.32	99.04	99.15
Minor and trace elements in ppm except as noted					
U	58.2	2.84	13.5	13.4	6.46
Th	27.6	18.8	0.982	31.8	20.8
S-T%	n.a.	0.000	0.099	0.018	n.a.
C-T%	0.075	0.029	0.028	0.136	0.054
Ba	499	<100	<100	835	433
Co	9.59	6.14	6.03	12.2	12.9
Cr	48.3	52.6	1.08	129	50.1
Cs	3.18	2.67	3.25	6.68	2.53
Hf	6.51	6.79	1.16	7.73	3.85
Rb	135	68.2	62.3	193	107
Sb	<0.081	0.0886	0.0874	0.395	<0.068
Sr	<100	<100	<100	<100	<100
Ta	1.54	1.05	1.80	1.84	1.10
Zr	186	238	35	234	129
Sc	11.3	11.2	10.1	27.9	11.7
La	55.0	35.1	6.28	83.4	52.8
Ce	110	68.6	9.49	165	97.5
Nd	44.7	27.1	3.98	67.5	41.9
Sm	8.88	5.25	0.892	13.6	7.74
Eu	1.1	0.468	0.211	1.98	0.885
Gd	6.89	n.r.	1.3	11.0	6.48
Tb	1.12	0.669	0.515	1.60	0.960
Dy	5.89	3.61	3.48	9.71	5.02
Tm	0.501	0.334	0.357	0.824	n.r.
Yb	3.01	2.25	1.95	5.00	2.64
Lu	0.452	0.329	0.244	0.670	0.400

Table 3 (Cont'd.)

Sample ID+	V111V	V123V	V123V	T129V	T129V
	132.6	149.7A	149.7B	164.1	198.2A
Major Elements in Weight Percent					
SiO ₂	58.10	55.70	66.20	64.10	n.r.
Al ₂ O ₃	16.30	14.30	12.80	10.30	n.r.
Fe ₂ O ₃	4.41	4.78	3.36	5.58	n.r.
FeO	2.74	2.97	2.31	1.59	5.19
Fe ₂ O ₃	1.36	1.48	0.79	3.81	n.r.
MgO	11.80	16.00	10.30	7.25	n.r.
CaO	0.14	0.05	0.07	0.07	n.r.
Na ₂ O	0.054	0.025	0.040	0.044	0.045
K ₂ O	1.92	<.02	1.02	1.22	n.r.
TiO ₂	0.34	0.23	0.25	0.39	n.r.
P ₂ O ₅	0.10	<.05	0.05	0.06	n.r.
MnO	0.019	0.035	0.031	0.031	0.058
F	0.12	0.11	0.07	0.07	0.13
LOI	6.86	8.67	5.95	10.80	n.r.
Total*	99.86	99.95	99.90	99.75	n.r.
Minor and trace elements in ppm except as noted					
U	68.2	3340	201	145	44300
Th	20.5	20.1	19.8	12.8	23.2
S-T%	n.a.	n.a.	n.a.	n.a.	n.a.
C-T%	n.a.	0.068	n.a.	4.84	0.019
Ba	200	<100	136	110	6500
Co	16.8	21.2	11.1	31.1	82.4
Cr	31.8	32.7	14.4	46.9	210
Cs	2.05	0.268	1.65	1.65	<0.91
Hf	6.95	1.8	6.57	2.81	64.2
Rb	68.8	<10	40.3	41.9	<10
Sb	0.14	1.15	0.161	0.31	8.9
Sr	<100	<100.	<100	<100	n.r.
Ta	1.55	0.87	1.18	0.955	0.066
Zr	450	13000	930	630	n.r.
Sc	9.83	17.0	7.27	9.98	154
La	37.4	5.00	12.6	12.9	n.r.
Ce	77.3	25	25.9	25.5	n.r.
Nd	35.7	n.r.	10.8	12	n.r.
Sm	7.36	10.7	2.64	2.55	n.r.
Eu	0.791	3.86	0.342	0.275	15
Gd	5.37	17.2	n.r.	2.55	n.r.
Tb	0.80	3.45	0.410	0.428	30.1
Dy	4.17	19.7	2.22	2.60	205
Tm	0.384	1.08	n.r.	n.r.	n.r.
Yb	2.20	5.51	0.955	1.69	100
Lu	0.300	n.r.	n.r.	0.272	15.7

Table 3 (Cont'd.)

Sample ID+	T129V 198.2B	T129V 202.2	T147V 160.0A	T147V 160.0B	T147V 204.2
Major Elements in Weight Percent					
SiO ₂	46.70	65.40	n.r.	65.40	n.r.
Al ₂ O ₃	16.90	15.80	n.r.	12.90	n.r.
Fe ₂ O ₃	3.92	3.26	n.r.	2.88	n.r.
FeO	2.41	1.96	0.97	0.37	1.88
Fe ₂ O ₃	1.24	1.08	n.r.	2.47	n.r.
MgO	19.50	6.06	n.r.	3.21	n.r.
CaO	0.12	0.13	n.r.	0.04	n.r.
Na ₂ O	0.029	0.075	0.066	0.071	0.041
K ₂ O	0.07	2.81	n.r.	3.46	n.r.
TiO ₂	0.66	0.60	n.r.	0.47	n.r.
P ₂ O ₅	0.06	0.09	n.r.	<.05	n.r.
MnO	0.025	0.005	0.013	0.006	0.042
F	0.14	0.07	0.08	0.08	0.10
LOI	11.60	4.94	n.r.	11.00	n.r.
Total*	99.47	99.02	n.r.	99.52	n.r.
Minor and trace elements in ppm except as noted					
U	159	5.73	33400	351	21200
Th	13.6	18.3	15	17.1	12.4
S-T%	n.a.	n.a.	1.255	2.133	0.353
C-T%	1.569	n.a.	5.238	6.473	0.747
Ba	44	265	5900	172	4000
Co	12.5	21.8	9.79	16.1	55.8
Cr	155	72	132	47.9	114
Cs	0.911	2.83	3.86	6.63	1.56
Hf	3.53	6.03	104	4.66	82.2
Rb	<10	72.8	59	136	<10
Sb	0.403	<0.080	9.39	0.442	6.19
Sr	<100	<100	n.r.	<100	<100
Ta	0.951	1.1	0.752	1.4	0.52
Zr	723	205	n.r.	94	n.r.
Sc	14.7	14.4	103	16.1	73.3
La	0.460	27.3	n.r.	2.95	17
Ce	1.3	50.9	n.r.	5.60	76
Nd	n.r.	19.5	n.r.	3.6	51
Sm	0.500	3.37	21.8	0.42	144
Eu	0.111	0.383	6.89	0.187	3.66
Gd	n.r.	n.r.	n.r.	n.r.	32
Tb	0.280	0.599	9.00	0.310	13.1
Dy	2.27	3.40	64.4	2.69	82.8
Tm	n.r.	0.375	11.6	0.344	3.85
Yb	1.50	2.38	26	2.23	33.2
Lu	n.r.	0.348	69	0.423	n.r.

Table 3 (Cont'd.)

Sample ID+	0162ND	S189V	N204V	T147V	0162ND
	242.9	239.4	477.1	217.1	281.8
Major Elements in Weight Percent					
SiO ₂	n.r.	56.90	n.r.	67.80	70.00
Al ₂ O ₃	n.r.	16.60	n.r.	14.40	15.30
Fe ₂ O ₃	n.r.	2.74	n.r.	2.52	2.07
FeO	1.03	1.24	3.23	0.88	1.24
Fe ₂ O ₃	n.r.	1.36	n.r.	1.54	0.69
MgO	n.r.	11.10	n.r.	7.00	4.51
CaO	n.r.	0.16	n.r.	0.12	0.10
Na ₂ O	0.020	0.063	0.075	0.054	0.101
K ₂ O	n.r.	1.24	n.r.	1.95	3.46
TiO ₂	n.r.	0.64	n.r.	0.39	0.48
P ₂ O ₅	n.r.	0.09	n.r.	0.07	0.09
MnO	0.019	0.022	0.027	0.030	0.012
F	0.04	0.06	0.15	0.08	0.22
LOI	n.r.	8.43	n.r.	5.56	4.48
Total*	n.r.	98.56	n.r.	99.91	100.69
Minor and trace elements in ppm except as noted					
U	13100	5790	13600	318	59.4
Th	30.4	16.7	20.1	22	19.2
S-T%	n.a.	n.a.	n.a.	0.019	n.a.
C-T%	3.208	0.888	n.a.	0.000	0.009
Ba	9600	4000	3600	253	375
Co	120	66	75.3	6.92	6.64
Cr	<50	116	82.1	28.0	53.8
Cs	<0.47	0.96	2.18	4.84	3.22
Hf	39	3.8	35	6.87	5.30
Rb	<2.5	26	68	74.9	106
Sb	9.23	3.50	4.32	0.095	<0.074
Sr	<75	<75	<75	<100	<100
Ta	<2.7	1.1	1.7	1.18	1.11
Zr	n.r.	n.r.	n.r.	<670	171
Sc	23.4	27.9	37.4	9.94	13.5
La	n.r.	36.7	118	26.5	44.7
Ce	n.r.	232	280	59.8	89.3
Nd	n.r.	138	355	28.1	38.2
Sm	<15	18	29.0	4.35	7.32
Eu	5.88	2.90	8.22	0.423	0.773
Gd	32.8	18	42.8	4.85	6.46
Tb	8.69	4.13	12.2	0.899	0.977
Dy	43.0	24.0	68.6	5.65	5.64
Tm	2.1	n.r.	4.05	0.407	0.482
Yb	11.9	6.93	21.7	3.04	3.16
Lu	n.r.	n.r.	n.r.	0.350	0.484

Table 3 (Cont'd.)

Sample ID+	S177V	S189V	V123V	T147V	T147V
	279.1	264.3	206.2	300.0	309.0
Major Elements in Weight Percent					
SiO ₂	65.30	69.70	63.50	65.30	93.50
Al ₂ O ₃	17.00	15.20	16.10	14.70	1.51
Fe ₂ O ₃	2.54	1.23	4.14	3.48	0.46
FeO	1.96	0.62	2.77	2.32	0.44
Fe ₂ O ₃	0.36	0.54	1.06	0.90	-0.03
MgO	5.55	4.95	7.26	7.00	1.04
CaO	0.22	0.12	0.19	0.13	0.15
Na ₂ O	0.024	0.110	0.025	0.088	0.038
K ₂ O	2.86	3.01	2.23	2.31	0.03
TiO ₂	0.61	0.62	0.54	0.58	0.02
P ₂ O ₅	0.12	0.09	0.12	0.07	<.05
MnO	0.041	0.009	0.038	0.034	0.009
F	0.07	0.06	0.08	0.07	<.01
LOI	5.53	4.14	6.20	5.19	1.17
<hr/>					
Total*	99.65	99.18	100.11	98.87	98.44
Minor and trace elements in ppm except as noted					
U	7.21	66.1	4.96	1580	4930
Th	25.7	17.6	19.5	15.2	2.14
S-T%	0.018	n.a.	n.a.	n.a.	n.a.
C-T%	0.078	0.030	n.a.	n.a.	n.a.
Ba	<100	302	35.5	430	3130
Co	6.51	4.26	12.8	10.3	4.53
Cr	27.7	64.6	59.9	61.1	<66
Cs	4.65	3.62	3.39	3.89	<0.099
Hf	13.2	5.93	6.06	5.24	n.r.
Rb	69.0	88.8	63.6	93	<2.5
Sb	0.0815	0.064	0.110	0.337	0.968
Sr	<100	<100	<100	<75	<75
Ta	1.30	1.20	0.992	1.10	<0.53
Zr	440	202	187	162	n.r.
Sc	9.5	15.8	13.0	15.5	9.18
La	11.1	36.8	30.0	11.0	26.0
Ce	23.1	71.3	63.4	41	206
Nd	10.2	31.0	26.5	42	60
Sm	2.18	5.73	4.50	n.r.	6.9
Eu	0.232	0.696	0.639	0.89	1.57
Gd	n.r.	4.87	n.r.	6.5	8.5
Tb	0.451	0.859	0.437	1.11	3.00
Dy	3.24	4.99	2.80	6.94	17.3
Tm	0.400	0.475	0.271	n.r.	n.r.
Yb	2.58	2.99	1.95	3.24	5.74
Lu	0.393	0.453	0.282	n.r.	n.r.

Table 3 (Cont'd.)

Sample ID+	T147V	T147V
	313.6	330.2
	Major Elements in Weight Percent	
SiO ₂	68.60	49.20
Al ₂ O ₃	10.60	13.30
Fe ₂ O ₃	3.36	12.20
FeO	2.25	8.95
Fe ₂ O ₃	0.86	2.25
MgO	10.00	14.60
CaO	0.16	0.32
Na ₂ O	0.030	0.022
K ₂ O	0.03	<.02
TiO ₂	0.27	1.43
P ₂ O ₅	<.05	0.20
MnO	0.021	0.148
F	0.06	0.09
LOI	6.03	7.61
<hr/>		
Total*	99.23	98.19

	Minor and trace elements in ppm except as noted	
U	2810	633
Th	9.11	7.23
S-T%	0.018	0.010
C-T%	0.046	0.009
Ba	1400	<100
Co	11.0	49.7
Cr	81.5	416
Cs	0.314	0.56
Hf	5.92	5.94
Rb	<10	<10
Sb	0.226	0.19
Sr	<100	<100
Ta	0.67	1.11
Zr	n.r.	300
Sc	14.6	30.8
La	10.2	4.58
Ce	27	<53
Nd	14	6.3
Sm	2.63	1.74
Eu	1.03	0.621
Gd	4.18	n.r.
Tb	1.09	0.757
Dy	7.72	5.28
Tm	0.560	n.r.
Yb	3.33	2.57
Lu	0.380	<5.6

+ Sample ID's are listed by drillhole number and downhole depth in meters.

* Total includes U as UO₂. Where FeO is not reported and Fe₂O₃ is not calculated, the total listed includes total iron reported as Fe₂O₃ (FeT₃). Otherwise, the total reflects FeO plus the calculated Fe₂O₃ and FeT₃ is ignored.

n.r. = not reported (usually due to analytical interferences).

n.a. = not analyzed.

Analysts

XRF: J. S. Wahlberg, J. Taggart, and J. W. Baker, Project Leader J. E. Taggart.

INAA & DN: J. Storey, J. Budahn, R. Knight, S. Danahey, R. B Vaughn, M. Coughlin, Project Leader D. M. McKown.

FeO and F: J. Graves, M. Manser, G. Mason, H. Neiman, F. Newman, and E. Engleman, Project Leader L. L. Jackson.

S and C for Ranger samples: J. Ryder, Project Leader L. L. Jackson.

S and C for Jabiluka samples: L. C. Gundersen.

Analytical Techniques--Ranger and Jabiluka Samples

XRF	INAA	Other
SiO ₂	Na ₂ O	LOI - Gravimetric
Al ₂ O ₃	MnO	FeO - Wet chemistry
FeT ₃	All elements	Fe ₂ O ₃ - Calculated from total Fe
MgO	listed	and FeO
CaO	under "Minor	S & C - LECO analyzer
K ₂ O	and Trace"	U - Delayed Neutron Analysis
TiO ₂	except U,	F - Specific ion electrode
P ₂ O ₅	S, and C.	

Note: Neutron induced fission of uranium results in direct spectral interferences for the INAA measurement of La, Sm, Nd, Ce, and Zr. A numerical correction is applied to nullify these interferences, but for samples containing very high abundances of uranium, the correction required is so large that the accuracy of the final result is greatly decreased. McKown (Appendix II in Frishman, 1984) provides a slightly more complete discussion of these analytical difficulties.

Table 4
Sample descriptions for samples from Ranger and Jabiluka

RANGER			Stratigraphic Unit (Ranger Mine Stratigraphy)
Sample Number	Description		
Ranger 1 No.1 orebody			
138 51.5	Chloritized schist		UMS
56 22C	Chlorite-mica schist		UMS
70 15.3	Weathered chlorite-sericite-quartz schist		UMS
70 26.4	Quartz-sericite schist		UMS
70 28.5	Chlorite-quartz schist		UMS
79 106.0	Chlorite schist		UMS
80 36C	Chlorite schist		UMS
80 47.6	Hematitic jasperoid		UMS
80 54C	Chlorite-mica schist		UMS
29 17.3	Chloritic, hematitic jasperoid		LMS
32 47.5	Dark green chlorite rock		LMS
138 163C	Chloritic carbonate		LMS
138 193.8	Chlorite-altered carbonate		LMS
55 138.2	Brecciated chlorite-sericite-quartz schist		LMS
55 194.9	Chloritized granitic dike		LMS
64 103.0	Chloritized jasperoid		LMS
64 138.0	Massive chlorite-bearing carbonate		LMS
165 92.8	Brecciated chlorite-quartz rock		LMS
70 112.0	Chloritized granitic dike		LMS
70 113.0	Mineralized, chloritized granitic dike		LMS
70 143.0	Chlorite-rich portion of chloritized granitic dike		LMS
73 44.1	Chlorite rock		LMS
79 234.9	Massive chlorite rock		LMS
80 68.2	Chloritized jasperoid		LMS
80 178C	Chloritic marble		LMS
33 27.7	Chlorite-mica schist		LS
64 151.4	Lenticle schist		LS
73 47.6	Quartz-chlorite-muscovite schist		LS
73 103C	Lenticle schist		LS
78 145C	Lenticle schist		LS
161 258C	Shear zone		SZ
64 194.0	Massive chlorite + quartz rock		SZ
70 166.1	Chlorite-quartz schist		SZ
33 123.7	Slightly altered K-feldspar-biotite gneiss		FWS
73 178.3	Chloritized biotite gneiss		FWS
Ranger 1 No.3 orebody			
59 64.8	Chloritized quartzite		KOM
97 86.6	Massive quartz-chlorite rock		KOM
97 90.2	Granular quartz-chlorite rock		KOM
83 158.6	Chloritized granitic dike		HWS/UMS
81 72.4	Chlorite schist, foliation disrupted		UMS
130 343.5	Graphitic schist with pyrite		UMS
130 348.5	Graphitic schist with chalcopyrite in quartz vein		UMS

Table 4 (Cont'd.)

97	67.1	Brecciated, hematitic chlorite-quartz schist	LMS
83	294.9	Massive chloritic jasperoid	LMS
83	516.8	Recrystallized carbonate with biotite-bearing chlorite seam	LMS
Ranger PMF drillhole (between No.1 and No.3 orebodies)			
PMF-1	172.2	Quartz-muscovite schist	HWS
PMF-1	221.9	Quartz-muscovite schist	HWS
Ranger 19			
19	268.5	Quartz-biotite-hornblende schist	UMS
19	327.8	Foliated chloritic marble	LMS
19	337C	Clean pink marble	LMS
JABILUKA			
Sample Number	Description	Stratigraphic unit (Jabiluka Mine stratigraphy)	
Jabiluka 1			
Y069V-	39.3	Quartz-chlorite-sericite schist	HWS
Y069V-	73.5	Quartz-chlorite-graphite schist	MMS
AN048V-	31.2	Quartz-chlorite-muscovite schist	MMS
Outside of Jabiluka 1 or between Jabiluka 1 and 2			
GN042V-	119.8	Amphibolite (meta-dolerite)	undefined
GN042V-	110.2	Brecciated garnetite (see Nutt, 1985)	undefined
X102V-	121.7	Carbonate veinlet	MMS
X102V-	143.0	Quartz-chlorite-muscovite schist	FWS
Jabiluka 2			
T147V-	54.0	Chloritized, hematite-bearing sandstone	KOM
O162ND-	41.1	Sandstone	KOM
O162ND-	143.2	Massive dark green chlorite	KOM
S177V-	137.6	Sandstone - minor hematite stain	KOM
S189V-	153.7	Porous hematite bearing sandstone	KOM
N204V-	246.7	Massive dark green chlorite	KOM
N204V-	264.5	Massive light to dark green chlorite	UNC
O162ND-	150.5	Brecciated chlorite-sericite-muscovite schist	USS
V111V-	50.0	Quartz-chlorite-graphite schist	UGS
V123V-	76.7	Siliceous zone (breccia?)	UGS
T129V-	90.8	Quartz-chlorite-graphite schist	UGS
T141V-	100.4	Siliceous breccia	UGS
O162ND-	159.6	Graphitic schist with sulfide stringer	UGS
T129V-	149.0A	Dark-green chlorite-quartz schist	HWS
T129V-	149.0B	Light-green quartz-chlorite-sericite schist	HWS
T147V-	118.0	Quartz vein	HWS
O162ND-	207.0	Pink carbonate vein and chlorite- muscovite schist	HWS

Table 4 (Cont'd.)

0162ND-214.3	Laminated quartz-chlorite-sericite breccia	HWS
S177V-156.5	Quartz-muscovite-chlorite schist	HWS
S177V-186.7	Quartz-chlorite-sericite schist	HWS
S177V-226.0	Pegmatite	HWS
S189V-188.5	Muscovite-chlorite quartz schist	HWS
N204V-311.4	Quartz-chlorite-muscovite schist with garnet pseudomorphs	HWS
V111V-132.6	Quartz vein with chlorite alteration	MMS
V123V-149.7A	U-bearing chlorite breccia	MMS
V123V-149.7B	Quartz-chlorite-sericite schist	MMS
T129V-164.1	Quartz-chlorite-muscovite-graphite schist	MMS
T129V-198.2A	U-vein in quartz-chlorite-graphite schist	MMS
T129V-198.2B	Quartz-chlorite-graphite schist	MMS
T129V-202.2	Quartz-chlorite-muscovite schist	MMS
T147V-160.0A	U vein in quartz-graphite schist	MMS
T147V-160.0B	Quartz-graphite schist	MMS
T147V-204.2	Quartz-uraninite-sulfide vein or breccia	MMS
0162ND-242.9	Chlorite-graphite schist	MMS
S189V-239.4	Quartz-graphite schist	MMS
N204V-477.1	Chlorite+uraninite	MMS
T147V-217.1	Quartz-chlorite schist	FWS
0162ND-281.8	Quartz-chlorite-sericite schist	FWS
S177V-279.1	Quartz-chlorite-muscovite-biotite schist	FWS
S189V-264.3	Quartz-muscovite-chlorite schist	FWS
V123V-206.2	Quartz-chlorite-sericite schist	LM1
T147V-300.0	Quartz-chlorite-muscovite schist	LM2
T147V-309.0	Silicified zone (healed breccia?)	LM2
T147V-313.6	Quartz-chlorite schist	LM2
T147V-330.2	Massive chlorite + quartz (amphibolite?)	LM2

Key to abbreviations
Jabiluka stratigraphy

KOM = Kombolgie Formation
 UNC = Unconformity
 USS = Upper Schist Series
 UGS = Upper Graphite Series
 HWS = Hangingwall Schist Series
 MMS = Main Mine Series
 FWS = Footwall Schist Series
 LM1 = Lower Mine Series 1
 LM2 = Lower Mine Series 2

See Nutt and Grauch (1983)
 for descriptions of the
 Jabiluka mine stratigraphy.

Key to abbreviations
Ranger stratigraphy

KOM = Kombolgie Formation
 HWS = Hangingwall Sequence
 UMS = Upper Mine Sequence
 LMS = Lower Mine Sequence
 LS = Lenticle Schist
 SZ = Footwall Shear Zone
 FWS = Footwall Sequence

See Eupene and others (1975)
 and Nash and Frishman (1982) for
 descriptions of the Ranger mine
 stratigraphy.