Appendix (A) and Supplemental (S) Data

Appendix A1. Location of outcrop and core localities.

Appendix A2. Analytical Methods.

Figure S1. Composite peaks comprising the broad illitic peak in bentonite, mixed (bentonite + normal) shale, and compacted normal shale samples of the Verulam Formation. Using the program *MacDiff*, designation of well to poorly crystallized illite follow the terminology and designation of Meunier and Velde (2004). An elevated abundance of well-crystallized illite occurs in the compacted shale, and a shift to higher d-spacings with increased smectite content.

Figure S2. Shift in d-spacing of illitic peaks toward the expected (~9.95-10.00) value for normal compacted grey shale, Lebreton well. Samples: RU3, bentonite, GSC #2 Russell core; LEB15, normal shale equivalent to the bentonite, GSC Lebreton core; and, NP7, normal shale younger than the bentonite, Nepean Point. Stratigraphic positions of samples are shown in Fig. 4 and 5.

Figure S3. Biotite composition, Verulam bentonite relative to the standard quadrilateral matrix for Fe and Mg bearing sheet-silicates. Also shown are biotites from the Milbrig, Deike and Kinnekulle bentonites that occur at or near the base of the Trenton Group, eastern North America, and equivalent succession in Sweden (Haynes et al., 1995; Min et al., 2001).

Table S1. Biotite geochemistry: Verulam Formation

Table S2. Comparative mica geochemistry, Upper Ordovician bentonites

Table S3. Geochemistry of chlorite and illite alteration of biotite, Verulam Formation

Table S4. Major oxides: Verulam bentonite, mixed shale, and compacted shale

Table S5. Trace elements: Verulam bentonite, mixed shale, and compacted shale

Reference Cited

Meunier, A., and Velde, B., 2004, Illite: Berlin, Springer, 286 p.

Appendix A1

Table A1: LOCATION OF CORE AND OUTCROP LOCALITIES

Locality	Longitude	Latitude	Easting	Northing	Map Sheet*	Grid Zone
Core						
GSC Russell #2	75° 23' 45" W	45° 19' 14" N	468968	5018628	Ottawa 31G/5	18T
GSC Lebreton	75° 42' 14"	45° 23' 56"	444900	5027500	Ottawa 31G/5	18T
GSC Billings Bridge	75° 40' 38"	45° 23' 17"	446986	5026296	Ottawa 31G/5	18T
Outcrop						
Nepean Point	75° 42' 10"	45° 25' 50"	445150	5030750	Ottawa 31G/5	18T

*topographic map, 1: 50 000

Appendix A2

ANALYTICAL METHODS

Core from well sites and the single outcrop section used in this study lie within and just outside the limits of the City of Ottawa, Ontario, Canada. Geographic details are given in Appendix A. The cores are housed at the Geological Survey of Canada's (GSC) Tunney's Pasture facility.

Shale Bed Abundance

Continuous cores and the Nepean Point outcrop section were mapped in detail to identify the stratigraphic position and abundance of shale beds > 1 cm in thickness. The scale of sections illustrated in Fig. 3 do not allow illustration of each shale bed, but, instead, the thicker black lines are intervals of abundant closely spaced shale beds.

Bentonite

Detailed stratigraphy and lithology of the interval bracketing the bentonite occurrences in the cores from the GSC Russell #2 and Billings Bridge were mapped, and samples selected from carbonate and shale below, within, and above the bentonite for petrographic and geochemical analyses (see text Fig. 4 and 5).

There is not a lot of material available for sampling: the bentonite is only ~6 cm thick, and the cores are 3 cm in diameter, but sawn in half, with one half preserved at the core facility. Under GSC protocol, only ¼ of the original core material can be sampled. Two other localities were considered potential targets for the bentonite occurrence: the GSC Lebreton well and the outcrop section at Nepean Point (see text Fig. 4). No bentonite was recognized, but samples of shale were collected from within the interpreted equivalent stratigraphic level in the GSC Lebreton core, and spanning the overlying outcrop section at Nepean Point (see text Fig. 4).

The bentonite was easily disaggregated by hand in distilled water with an added dispersing agent (50ml of 5% Calgon). The solution was then washed with distilled water. The more compacted (non-bentonitic) shale was disaggregated after two days of soaking in the above solution. Once dried, all samples were subdivided. One part was used for sediment-size distribution, following addition of 10% HCl acid in order to dissolve individual skeletal and diagenetic carbonate. Grain size separation involved wet sieving using standard size separation intervals, with a minimum 63-μm mesh defining the sand-mud boundary.

Slurries of powdered bulk-sediment and a < 2-micron fraction, separated by centrifuge, were pipetted onto glass slides, and allowed to air dry. The mineralogy was determined by x-ray diffractometry at the Geological Survey of Canada (Ottawa) using a Bruker D8 Advance Powder diffractomer, with settings of 40KV and 40mA; analysis using Co-Ka radiation (λ=1.793); and scanning over a 2 to 60 degree 2-theta range, at a scanning speed of 2 degrees 2-theta per minute and a chart speed of 2 cm/min. In total, twenty-three slides of compacted shale and bentonite were prepared and analyzed. For each sample, three slides were prepared: (1) air-dried; (2) exposure to ethylene glycol vapour for two hours; and, (3) heated, first to 400 Cº for at least half an hour, then heated to 550ºC, and kept at this temperature for a minimum of half an hour. RAW Bruker XRD files were converted into ASCII files using software *ConvX*. Peak identification, and decomposition of selected peak intervals through peak shape analysis, was carried out using freeware *MacDiff*.

Major element geochemistry was determined by Activation Laboratories Ltd., Ancaster, ON. The procedure uses a Phillips PW-2400 sequential XRF analyzer with Phillips Super Q software (Norrish, 1969). Analysis was carried out on 0.5 g of whole-rock powder following roasting at 1050^{o}C for 2 hours to determine loss on ignition. Cited detection limits are 0.01 %, and the reader is directed to their website (www.actlabs.com/methods). Trace element and rare earth concentrations were determined by ICP-MS from whole-rock powdered samples at the Ontario Geological Survey (Sudbury) laboratories following their preparation codes IM-100/101. Detection limits are summarized at http://www.mndm.gov.on.ca/mines/ogs/labs/geobroc.pdf.

Microprobe analyses of biotite and related clay (chlorite and illite) minerals were carried out at Carleton University on an automated 4-spectrometer Camera Camebax MBX electron probe by wavelength dispersive x-ray analysis (WDX). Operating settings were 15KV and a 20 nano-ampere beam current. Detection limits are estimated to be 100 ppm.

Textural, mineralogical, and qualitative element determination (based on secondary electron and backscatter analysis) was carried out Carleton University, and utilized a Tescan Vega-II XMU VPSEM, operating at 20 kV, with elemental analysis via an Oxford Inca Energy 250X energy dispersive spectrometer. Cathodoluminescence of carbonate that is interbedded with the bentonite was examined using an ELM-2 luminoscope (set at 0.5 milliamps, 12 kV, and < 40 millitorr).

Large (medium sand-size) biotite xenocrysts were sampled from the GSC Russell #2 core for potential absolute age-date analysis by the Ar-Ar method. Electron microscopy demonstrated extensive alteration by chlorite, and an attempt to age-date the relict biotite failed, producing concave up curves (Al-Dulami, 2010).

Table S1: Biotite geochemistry, Verulam Formation

	RU3			RU5	RU6		BB10	BB12		BB13
	#1	#2	#3	#1	#1	#2	#1	#1	#2	#1
SiO2	35.88	34.04	35.85	35.60	35.52	35.97	34.24	33.33	36.31	35.21
Al2O3	15.27	17.29	15.26	17.85	14.49	14.16	16.00	15.68	15.53	17.41
TiO2	4.74	4.08	4.89	3.99	4.54	4.94	3.94	6.10	4.22	3.88
Cr2O3	0.00	0.00	0.00	0.04	0.01	0.00	0.00	0.03	0.06	0.02
FeO	22.53	21.01	22.77	20.06	21.92	22.43	22.06	20.39	20.37	18.48
MgO	9.53	10.77	9.45	10.55	9.07	8.84	10.34	10.67	8.82	9.90
MnO	0.17	0.12	0.14	0.16	0.15	0.21	0.13	0.09	0.19	0.00
NiO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
K2O	7.28	5.57	7.38	6.19	7.72	8.36	6.16	5.14	7.65	5.78
CaO	0.01	0.00	0.12	0.04	0.09	0.08	0.00	0.01	0.08	0.03
Na2O	0.24	0.12	0.30	0.20	0.27	0.31	0.19	0.16	0.30	0.17
BaO	0.49	0.59	0.60	0.33	0.54	0.21	0.33	0.20	0.53	0.42
F	0.50	0.46	0.66	0.40	0.48	0.51	0.59	0.65	0.75	0.63
Cl	0.14	0.12	0.13	0.09	0.11	0.09	0.07	0.12	0.09	0.09
TOTAL	96.78	94.17	97.55	95.50	94.91	96.11	94.05	92.57	94.90	92.02
TOT-O	96.54	93.95	97.24	95.31	94.68	95.87	93.79	92.27	94.56	91.73
Si	5.48	5.26	5.45	5.37	5.54	5.56	5.35	5.23	5.61	5.48
Al^{iv}	2.52	2.74	2.55	2.63	2.46	2.44	2.65	2.77	2.39	2.52
SUBT	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
Al	0.22	0.41	0.19	0.55	0.21	0.14	0.29	0.13	0.44	0.68
Ti	0.54	0.48	0.56	0.45	0.53	0.57	0.46	0.72	0.49	0.46
Cr	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00
Fe	2.88	2.71	2.90	2.53	2.86	2.90	2.88	2.68	2.63	2.41
Mg	2.17	2.48	2.14	2.37	2.11	2.04	2.41	2.50	2.03	2.30
Mn	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.01	0.02	0.00
Ni	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SUBT	5.83	6.09	5.81	5.93	5.73	5.68	6.06	6.04	5.63	5.84
K	1.42	1.10	1.43	1.19	1.54	1.65	1.23	1.03	1.51	1.15
Ca	0.00	0.00	0.02	0.01	0.02	0.01	0.00	0.00	0.01	0.01
Na	0.07	0.04	0.09	0.06	0.08	0.09	0.06	0.05	0.09	0.05
Ba	0.03	0.04	0.04	0.02	0.03	0.01	0.02	0.01	0.03	0.03
SUBT	1.52	1.17	1.58	1.28	1.67	1.77	1.31	1.09	1.64	1.23
F	0.24	0.22	0.32	0.19	0.24	0.25	0.29	0.33	0.37	0.31
Cl	0.04	0.03	0.03	0.02	0.03	0.02	0.02	0.03	0.02	0.03

Table S1: Biotite geochemistry, Verulam Formation

SUBT	0.28	0.26	0.35	0.21	0.26	0.28	0.31	0.36	0.39	0.34

Biotite Summary

	RU3		RU5,6		BB10	BB12,13		Verulam Fm	
	n=3		n=3		n=1	n=3		n=10	
	X	se	X	se		X	se	X	se
SiO2	35.26	1.05	35.70	0.24	34.24	34.95	1.51	35.2	0.99
Al2O3	15.94	1.17	15.50	2.04	16.00	16.21	1.04	15.89	1.25
TiO2	4.57	0.43	4.49	0.48	3.94	4.73	1.20	4.53	0.68
FeO	22.10	0.95	21.47	1.25	22.06	19.75	1.10	21.2	1.38
Cr2O3	0.00	0.00	0.02	0.02	0.00	0.04	0.02	0.02	0.02
MgO	9.92	0.74	9.49	0.93	10.34	9.80	0.93	9.79	0.76
MnO	0.14	0.03	0.17	0.03	0.13	0.09	0.10	0.14	0.06
K2O	6.74	1.02	7.42	1.12	6.16	6.19	1.30	6.72	1.09
CaO	0.04	0.07	0.07	0.03	0.00	0.04	0.04	0.05	0.04
Na2O	0.22	0.09	0.26	0.06	0.19	0.21	0.08	0.23	0.07
BaO	0.56	0.06	0.36	0.17	0.33	0.38	0.17	0.42	0.15
F	0.54	0.11	0.46	0.06	0.59	0.68	0.06	0.56	0.11
Cl	0.13	0.01	0.10	0.01	0.07	0.10	0.02	0.11	0.02
TOTAL	96.17	1.77	95.51	0.60	94.05	93.16	1.53	94.86	1.74

TABLE S2: Comparative Mica Geochemistry, Upper Ordovician

	Verulam Fm* (n=10)		Billings Fm† (n=13)		Deicke§ (n=7)		Millbrig§ (n=8)		Kinnekulle§†† (n=6)		Deicke# (representative sample)	Millbrig#	Kinnekulle#
Oxide	X	se	X	se	X	se	X	se	X	se			
SiO_2	35.20	0.99	36.99	0.07	35.54	0.26	36.06	0.32	34.42	0.11	36.97	35.23	35.16
Al_2O_3	15.89	1.25	14.17	0.10	14.57	0.44	13.48	0.10	15.24	0.04	14.13	14.04	16.07
TiO_2	4.53	0.68	5.47	0.06	4.30	0.14	4.75	0.10	4.89	0.20	5.41	3.80	4.48
FeO	21.20	1.38	12.33	0.20	21.23	0.70	19.16	0.72	23.49	0.18	12.90	18.72	17.76
MgO	9.79	0.76	15.84	0.12	9.86	0.60	11.51	0.42	0.26	0.01	13.06	8.29	7.47
MnO	0.14	0.06	0.18	0.02	0.14	0.02	0.18	0.18	7.62	0.06	0.18	0.38	0.32
K_2O	6.72	1.09	8.26	0.05	8.89	0.07	8.87	0.10	0.07	0.01	8.74	8.75	8.42
CaO	0.05	0.04	0.01	0.01	0.06	0.01	0.04	0.01	0.45	0.02	0.20	0.01	0.06
Na_2O	0.23	0.07	0.61	0.02	0.49	0.03	0.37	0.01	8.55	0.04	0.36	0.36	0.41
BaO	0.42	0.15	1.64	0.06	0.41	0.09	0.45	0.07	0.56	0.12	nr	nr	nr
F	0.56	0.11	0.96	0.02	0.76	0.07	0.59	0.06	0.75	0.02	nr	nr	nr
Cl	0.11	0.02	0.03	0.03	0.11	0.01	0.14	0.03	0.20	0.01	nr	nr	nr
Total	94.84	1.74	96.50	1.30	96.38	0.44	95.61	0.51	96.50	0.27	96.25	95.82	96.07
X_{Mg}	0.45	0.03	0.69		0.51	0.01	0.45	0.01	0.36	0.01	0.64	0.43	0.42
A^{liv}	2.54	0.02	nr		nr		nr		nr		2.38	2.45	2.52

Symbols: X - mean; se - standard error; nr - not recorded

Sources: * - biotite, this study, † - phlogopite, Sharma et al. (2005), § - biotite, Min et al. (1991), # - biotite, Haynes (1995)

Other: †† - sample SWE52 from Min et al. (1991)

Table S3. Geochemistry of chlorite and illite alteration of biotite, Verulam Formation

ILLITE	RU3		RU5,6		BB10		BB12,13	
	n=2		n=10		n=3		n=2	
	X	range	X	se	X	se	X	se
SiO2	52.89	0.66	55.20	0.18	56.20	0.39	58.04	1.45
Al203	26.00	0.70	26.55	0.68	24.23	0.30	24.22	0.20
TiO2	0.75	0.02	0.58	0.49	1.30	0.12	1.04	0.52
Cr203	nd		0.03	0.02	0.01	0.01	0.01	0.01
FeO	1.63	0.00	1.22	0.47	1.49	0.09	2.22	1.13
MgO	3.69	0.04	3.38	0.16	3.37	0.08	3.83	0.43
MnO	nd		0.02	0.01	nd		0.03	0.02
K2O	6.41	0.33	6.83	0.28	6.64	0.03	6.57	0.02
CaO	2.08	0.10	1.58	1.39	1.49	0.04	1.23	0.36
Na2O	0.42	0.02	0.41	0.01	0.67	0.26	0.31	0.03
BaO	nd		0.04	0.01	nd		0.02	0.02
F	1.10	0.04	1.32	0.37	1.27	0.06	0.93	0.01
Cl	0.02	0.02	0.11	0.09	0.08	0.02	0.05	0.01
Total	94.99	1.16	97.25	1.08	96.75	0.42	98.50	0.55

Abbreviations: X - mean, se - standard error

Table S3. Geochemistry of chlorite and illite alteration of biotite, Verulam Formation

CHLORITE	RU3		RU5,6		BB10		BB12,13	
	n=2		n=10		n=2		n=4	
	X	range		se		se	X	se
SiO2	33.48	2.98	33.07	0.33	37.37	1.87	37.08	1.26
Al203	25.72	2.00	25.52	0.99	26.34	0.28	26.67	1.47
TiO2	0.03	0.05	0.05	0.04	0.05	0.01	0.01	0.01
Cr203	0.02	0.03	0.01	0.01	nd		0.01	0.01
FeO	14.41	3.60	14.78	1.14	12.28	1.17	14.03	0.22
MgO	13.18	1.30	0.01	0.01	0.03	0.04	10.53	2.76
MnO	0.04	0.04	13.40	0.47	11.67	1.20	0.02	0.01
K2O	1.12	0.80	0.99	0.25	0.12	0.01	1.81	0.13
CaO	0.13	0.12	0.12	0.01	2.20	0.77	0.16	0.04
Na2O	nd		nd		nd		nd	
BaO	nd		nd		nd		nd	
F	0.44	0.48	0.08	0.03	0.07	0.02	0.04	0.03
Cl	0.08	0.07	0.43	0.14	0.36	0.12	0.49	0.16
Total	88.63	1.00	88.46		90.45		90.82	

Abbreviations: X - mean, se - standard error

Table S4. Major oxides: Verulam bentonite, mixed shale, and compacted shale

Bentonite (RU series, BB10) and Mixed (Bentonite, Compacted Shale) Shale

Oxide	RU3	RU5	RU6	BB10	BB12	BB13
SiO_2	37.76	44.10	46.63	48.02	44.86	32.79
Al_2O_3	17.62	21.06	22.50	20.34	15.06	10.78
Fe_2O_3	4.25	3.29	3.76	3.78	3.56	2.58
MnO	0.01	0.01	0.01	0.02	0.02	0.03
MgO	3.08	3.42	3.34	2.97	2.40	1.90
CaO	12.53	7.18	3.81	4.51	11.45	23.67
Na_2O	0.57	0.91	0.84	0.70	0.54	0.48
K_2O	3.98	5.00	5.49	5.30	4.34	2.61
TiO_2	0.25	0.26	0.26	0.54	0.53	0.35
P_2O_5	0.20	0.17	0.15	0.13	0.15	0.16
Cr_2O_3	< 0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
LOI	16.41	12.76	10.96	11.94	14.63	22.07
Total	96.66	98.17	97.75	98.24	97.54	97.41

GSC Russell #2 core: RU3 - upper bed; RU5 and 6 - lower bed
GSC Billings Bridge core: BB10 - upper bed; BB12 and BB13 - lower bed

Compacted Shale

Oxide	RU1	RU2	LB15	NP1	NP2	NP3	NP4	NP5	NP6	NP7
SiO_2	34.01	41.49	47.22	36.09	34.41	34.22	43.81	33.57	27.17	31.22
Al_2O_3	10.7	12.66	14.92	11.65	10.9	10.27	15.52	9.58	7.45	10.71
Fe_2O_3	2.73	2.71	3.67	2.09	2.1	2.06	2.61	2.31	2.23	2.52
MnO	0.029	0.043	0.027	0.033	0.032	0.032	0.021	0.036	0.033	0.031
MgO	2.34	2.41	2.97	1.68	1.65	1.53	2.05	1.53	1.77	1.64
CaO	21.69	16.81	10.26	21.45	23.19	24.05	12.55	25.05	29.7	24.78
Na_2O	0.89	0.53	0.37	0.25	0.26	0.36	0.21	0.24	0.33	0.38
K_2O	1.75	2.59	4.41	2.83	2.78	2.54	4.39	2.47	1.76	2.25
TiO_2	0.45	0.51	0.63	0.5	0.47	0.47	0.64	0.43	0.33	0.49
P_2O_5	0.14	0.08	0.11	0.14	0.14	0.14	0.13	0.08	0.11	0.22
Cr_2O_3	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	< 0.01
LOI	23.11	18.93	14.41	21.51	22.51	22.92	17.31	22.74	25.9	23.8

Table S4. Major oxides: Verulam bentonite, mixed shale, and compacted shale

Total	97.85	98.77	99.01	98.23	98.45	98.61	99.25	98.05	96.79	98.04

GSC Russell #2 core: RU1, RU2
GSC Lebreton core: LB15
Nepean Point (outcrop): NP1 - NP7

Table S5. Trace elements: Verulam bentonite, mixed shale, and compacted shale

Bentonite (RU series, BB10) and Mixed (Bentonite, Compacted Shale)

Element	RU3	RU5	RU6	BB10	BB12	BB13
La	13.84	1.39	9.04	18.59	26.34	25.48
Ce	32.20	3.90	23.00	41.80	52.20	54.80
Pr	4.24	0.61	3.20	4.95	5.91	6.39
Nd	17.19	2.96	14.01	18.94	21.47	24.23
Sm	4.29	1.09	4.07	4.42	4.28	4.72
Eu	0.38	0.11	0.40	0.94	0.82	0.87
Gd	4.03	1.34	4.05	3.88	3.66	3.88
Tb	0.71	0.29	0.76	0.64	0.57	0.58
Dy	4.70	2.10	4.90	4.00	3.50	3.70
Ho	0.90	0.46	0.91	0.79	0.69	0.71
Er	2.62	1.37	2.50	2.31	2.01	2.09
Tm	0.40	0.21	0.35	0.34	0.31	0.32
Yb	2.65	1.37	2.13	2.15	2.14	2.14
Lu	0.36	0.19	0.28	0.33	0.32	0.33
Nb	4.78	8.00	9.25	19.61	16.58	11.50
Y	21.77	9.23	19.28	19.92	17.32	18.66
Zr	136.00	221.00	199.00	362.00	294.00	214.00
Ta	1.10	2.70	2.40	1.60	1.00	0.80
Th	20.41	7.37	31.34	19.97	13.22	11.89
Rb	79.60	18.80	42.60	77.20	159.70	116.10

GSC Russell #2 core: RU3 - upper bed, RU5, 6 - lower bed
GSC Billings Bridge core: BB10 - upper bed, BB12, 13 - lower bed

Table S5. Trace elements: Verulam bentonite, mixed shale, and compacted shale

Compacted Shale

Element	RU1	RU2	RU7	RU8	Leb15	NP-1	NP-2	NP-3	NP-4	NP-5	NP-6	NP-7
La	31.62	53.68	40.45	54.13	26.50	22.08	19.04	21.40	25.70	26.27	18.23	19.28
Ce	56.50	89.50	70.80	91.50	46.30	38.30	35.20	37.40	41.30	46.30	35.50	34.20
Pr	5.76	8.48	7.19	9.03	4.57	3.65	3.57	3.70	3.91	4.51	3.71	3.60
Nd	19.28	26.21	24.01	28.92	14.18	12.37	12.55	12.71	11.79	14.40	12.37	12.57
Sm	3.54	4.22	4.37	5.18	2.29	2.24	2.36	2.29	1.84	2.30	2.19	2.31
Eu	0.50	0.55	0.61	0.68	0.45	0.41	0.42	0.42	0.33	0.44	0.44	0.45
Gd	2.99	3.19	3.49	3.96	1.65	1.81	1.90	1.82	1.38	1.77	1.69	1.76
Tb	0.44	0.52	0.54	0.63	0.26	0.29	0.29	0.30	0.23	0.29	0.27	0.27
Dy	2.70	3.10	3.20	3.70	1.60	1.80	1.80	1.80	1.40	1.70	1.60	1.50
Ho	0.52	0.62	0.64	0.72	0.33	0.39	0.37	0.38	0.30	0.36	0.31	0.31
Er	1.54	1.83	1.81	2.11	1.02	1.18	1.15	1.17	0.98	1.06	0.94	0.96
Tm	0.23	0.29	0.29	0.31	0.16	0.19	0.18	0.18	0.16	0.17	0.14	0.15
Yb	1.47	1.98	1.98	2.15	1.10	1.25	1.18	1.24	1.11	1.15	0.95	0.98
Lu	0.24	0.30	0.31	0.32	0.17	0.20	0.18	0.19	0.17	0.17	0.14	0.15
Nb	9.65	19.21	14.42	20.73	11.43	10.61	7.83	10.18	12.92	8.83	5.87	9.17
Y	15.56	15.70	17.86	19.09	8.32	10.31	10.39	10.45	7.75	9.16	8.42	8.90
Zr	126.00	125.00	120.00	122.00	141.00	136.00	128.00	140.00	127.00	117.00	75.00	93.00
Ta	0.70	0.80	0.60	0.70	0.80	0.80	0.60	0.70	0.90	0.60	0.40	0.60
Th	11.74	11.91	8.47	10.04	11.79	11.46	8.85	11.03	11.12	9.29	6.42	8.91
Rb	121.10	155.70	110.30	141.40	194.20	154.20	112.90	144.90	199.20	132.50	104.10	143.40