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ANEXOS

Tabela A.1 (Anexo I) – Figuras de mérito das curvas analíticas nas análises por SN-ICPMS para validação dos padrões de vidro borato. Valores para os coeficientes de determinação (R^2) e da inclinação (b) das retas contendo sete pontos, e que passam pelo ponto de origem.

Analito	m/z	R^2	b (kg/μg)	faixa dinâmica (μg/kg)
Na	23	0,9993	0,0326	0-1100
Al	27	0,9574	0,0316	0-100
K	39	0,9995	0,0396	0-1100
Ca	44	0,8616	0,0216	0-1100
Sc	45	0,9981	0,0521	0-100
Ti	47	0,8212	0,0071	0-100
Ti	48	0,6072	0,0094	0-100
V	51	0,9993	0,039	0-100
Cr	53	0,9997	0,0041	0-100
Mn	55	0,9992	0,041	0-100
Fe	57	0,9911	0,0028	0-1100
Co	59	0,9996	0,031	0-100
Ni	60	0,9990	0,0076	0-100
Ni	62	0,9988	0,0012	0-100
Zn	66	0,9996	0,0048	0-100
Ga	71	0,9996	0,018	0-100
Rb	85	0,9998	0,045	0-100
Sr	88	0,9995	0,054	0-100
Y	89	0,9988	0,068	0-100
Zr	90	0,9997	0,033	0-100
Nb	93	0,9998	0,058	0-100
Rh	103	0,8372	3488	0-100
In	115	0,9959	0,176	0-100
Ba	138	0,9997	0,051	0-100
La	139	0,9996	0,072	0-100
Ce	140	0,9998	0,062	0-100
Pr	141	0,9997	0,074	0-100
Nd	142	0,9997	0,021	0-100
Sm	152	0,9997	0,020	0-100
Eu	153	0,9998	0,038	0-100
Gd	158	0,9999	0,018	0-100
Tb	159	0,9997	0,067	0-100
Dy	164	0,9999	0,019	0-100
Ho	165	0,9998	0,063	0-100
Er	166	0,9998	0,022	0-100
Tm	169	0,9997	0,062	0-100
Yb	174	0,9996	0,020	0-100
Lu	175	0,9995	0,057	0-100
Ta	181	0,9997	0,054	0-100
Pb	208	0,9994	0,021	0-100
Th	232	0,9999	0,042	0-100
U	238	0,9998	0,039	0-100

Anexo II

Tabela A.2 – Resultados da validação de alvo padrão: vidro borato (1:5) de basalto NIST SRM 688. Fragmentos dos alvos de calibração foram dissolvidos em HNO_3 e as soluções analisadas por SN-ICPMS.

Elemento	Concentração (µg kg^{-1})	
	Valor esperado	SN-ICPMS
Ce	2.000	2.300 ± 110
Co	8.580	7.860 ± 390
Cr	55.300	55.400 ± 3.700
Er	316	410 ± 30
Ga	2.832	3.260 ± 200
Gd	483	610 ± 30
Ho	110	130 ± 20
La	816	1.010 ± 50
Mn	215.000	290.000 ± 22.000
Nd	1.399	1.620 ± 220
Pr	333	330 ± 20
Sr	27.000	36.600 ± 1.800
Ta	52	50 ± 10
U	62	50 ± 10
Y	2.815	3.500 ± 200
Zn	13.500	14.600 ± 1.500

Tabela A.3 – Resultados da validação de alvo padrão: vidro borato (1:11) de basalto NIST SRM 688. Fragmentos dos alvos de calibração foram dissolvidos em HNO_3 e as soluções analisadas por SN-ICPMS.

Elemento	Concentração (µg kg^{-1})	
	Valor esperado	SN-ICPMS
Ce	1.004	1.030 ± 30
Co	4.310	3.350 ± 280
Cr	27.800	24.850 ± 930
Er	159	159 ± 10
Eu	74	66 ± 3
Ga	1.422	1.430 ± 80
Gd	243	253 ± 20
Ho	55	47 ± 5
La	410	430 ± 30
Lu	22	12 ± 1
Nb	435	280 ± 20
Nd	703	670 ± 60
Pr	167	130 ± 10
Y	1.413	1.500 ± 100
Zn	6.775	6.500 ± 200

Tabela A.4 – Resultados da validação de alvo padrão: vidro borato (1:11) de obsidiana NIST SRM 278. Fragmentos dos alvos de calibração foram dissolvidos em HNO_3 e as soluções analisadas por SN-ICPMS.

Elemento	Concentração (μg kg^{-1})	
	Valor esperado	SN-ICPMS
Ce	5.457	4.400 ± 240
Cr	532	800 ± 250
Er	344	310 ± 20
Ga	1.847	1.500 ± 130
Gd	479	530 ± 60
Ho	110	90 ± 10
La	2.519	2.300 ± 130
Lu	54	40 ± 10
Mn	34.000	37.000 ± 3.000
Nb	1.797	1.140 ± 60
Nd	2.267	2.100 ± 160
Sm	470	420 ± 40
Sr	5.037	5.200 ± 740
Ta	126	100 ± 10
Th	1.016	930 ± 120
U	395	340 ± 20
Zn	4.450	3.900 ± 300

Tabela A.5 – Resultados da validação de alvo padrão: vidro borato (1:23) de obsidiana NIST SRM 278. Fragmentos dos alvos de calibração foram dissolvidos em HNO_3 e as soluções analisadas por SN-ICPMS.

Elemento	Concentração (μg kg^{-1})	
	Valor esperado	SN-ICPMS
Ce	2.697	1.440 ± 130
Co	830	624 ± 520
Cr	263	n.a.
Eu	28	5 ± 1
Ga	913	440 ± 20
Gd	236	130 ± 10
Ho	54	16 ± 2
La	1.245	700 ± 70
Lu	27	20 ± 10
Mn	17.000	22.000 ± 9.000
Nb	888	530 ± 200
Nd	1.120	1.200 ± 350
Pr	290	320 ± 140
Sm	232	250 ± 120
Sr	2.490	3.000 ± 1.100
Ta	62	50 ± 30
Th	502	560 ± 250
Tm	26	15 ± 10
U	195	210 ± 90
Y	1.493	1.700 ± 700
Zn	2.200	2.500 ± 1.400

Tabela A.6 – Resultados da validação de alvo padrão: vidro borato (1:47) de obsidiana NIST SRM 278. Fragmentos dos alvos de calibração foram dissolvidos em HNO_3 e as soluções analisadas por SN-ICPMS.

Elemento	Concentração ($\mu g\ kg^{-1}$)	
	Valor esperado	SN-ICPMS
Ce	1.346	3.000 ± 1.300
Cr	131	n.a.
Er	85	185 ± 90
Ga	456	440 ± 20
Gd	118	130 ± 10
Ho	27	50 ± 30
La	621	1.500 ± 550
Mn	8.000	9.000 ± 800
Nd	559	600 ± 60
Pr	145	150 ± 10
Sm	116	110 ± 10
Sr	1.243	1.560 ± 130
Th	251	260 ± 30
Tm	105	90 ± 10
U	97	100 ± 10
Y	746	850 ± 50
Zn	1.100	1.400 ± 200

Anexo III

Tabela A.7 – Resultados da determinação de elementos no vidro borato (1:5) de basalto GSJ JB-2.

Elemento	Concentração (mg kg^{-1})[a]	
	Valor de referência	Este trabalho
Sc	54	59 ± 1
P	440	330 ± 15
V	578	580 ± 6
Cr	27	26 ± 31[b]
Mn	1.550	1.760 ± 60
Fe	10 %	(11 ± 1) %
Co	40	44 ± 8
Ni	14	14 ± 3[b]
Zn	110	110 ± 10
Ga	17	14 ± 1
Rb	6,2	6,5 ± 1,7
Sr	178	172 ± 5
Y	25	25 ± 1
Zr	51	55 ± 6
Sb	0,270	0,310 ± 0,005[b]
Ba	208	226 ± 17
La	2,4	2,4 ± 0,4
Ce	6,8	6,8 ± 0,5
Nd	6,7	7,0 ± 0,7
Sm	2,3	2,5 ± 0,2[b]
Eu	0,86	0,80 ± 0,07[b]
Tm	0,45	0,38 ± 0,04

[a] Unidades diferentes de concentração são indicadas.
[b] Exatidão e repetitividade da concentração melhoram com o emprego de câmara ciclônica

Tabela A.8 – Resultados da determinação de elementos no vidro borato (1:5) de granito NIM-G SARM-1.

Elemento	Concentração (mg kg^{-1})	
	Valor de referência	Este trabalho
Na	24.930	23.270 ± 250
Al	63.930	64.600 ± 700
Si	353.860	353.500 ± 11.600
K	41.420	39.930 ± 640
Ca	5.570	5.300 ± 1.030
Zn	50	52 ± 2
Ga	27,0	32,8 ± 2,0
Rb	325	274 ± 5
Zr	300	295 ± 12[a]
Nb	53	72 ± 7
Ba	120	129 ± 17
La	109	120 ± 6[a]
Ce	195	191 ± 12
Pr	19	23 ± 1[a]
Nd	72	66 ± 2[a]
Sm	16	14 ± 1[a]
Eu	0,35	0,31 ± 0,05[a]
Gd	14,0	12,8 ± 1,4[a]
Tb	3,0	2,6 ± 0,4[a]
Dy	17	19 ± 4[a]
Ho	3,6	4,4 ± 0,4
Er	10,5	11,1 ± 1,4[a]
Tm	2,0	2,2 ± 0,3[a]
Yb	14,2	11,9 ± 0,8[a]
Lu	2,00	1,96 ± 0,12[a]
Hf	12,4	13,1 ± 2,5[a]
Ta	0,20	0,20 ± 0,03[a]
Th	51	54 ± 3
U	15	15 ± 2

[a] Exatidão e repetitividade da concentração melhoram com o emprego de câmara ciclônica

Anexo IV

Tabela A.9 – Resultados da determinação de elementos no vidro borato (1:5) de basalto (USGS, BHVO-2).

Elemento	Concentração (mg kg^{-1})	
	Valor de referência	Este trabalho
Al	71.600	123.000 ± 15.000
Ba	130	170 ± 30
Ca	81.700	79.000 ± 7.000
Ce	38	40 ± 6
Co	45	43 ± 2
Cr	280	270 ± 5
Fe	86.300	81.000 ± 2.800
La	15	21 ± 1
Mn	1.290	1.290 ± 80
Nd	25	31 ± 2
Ni	119	90 ± 20
P	1.200	820 ± 60
Rb	9,8	8 ± 2
Sc	32	32 ± 2
Si	233.000	480.000 ± 47.000
Sr	389	350 ± 30
V	317	327 ± 6
Y	26	28 ± 2
Zn	103	110 ± 2
Zr	172	247 ± 6

Tabela A.10 – Resultados da determinação de elementos no vidro borato (1:5) de basalto (USGS, BCR-2).

Elemento	Concentração (mg kg^{-1})	
	Valor de referência	Este trabalho
Al	71.400	65.000 ± 7.000
Ba	683	760 ± 40
Ce	53	54 ± 7
Co	37	38 ± 2
Eu	2,0	1,8 ± 0,4
Fe	96.500	79.000 ± 2.700
Ga	23	19 ± 2
Ho	1,3	1,0 ± 0,1
K	14.900	13.600 ± 600
La	25	26 ± 1
Mn	1.520	1.300 ± 80
Nd	28	37 ± 3
Ni	119	90 ± 20
P	1.500	1.100 ± 80
Rb	48	40 ± 2
Sc	33	27 ± 2
Si	253.000	278.000 ± 28.000
Sr	346	280 ± 20
V	416	424 ± 8
Y	37	36 ± 3
Zn	127	130 ± 20
Zr	188	194 ± 5

Tabela A.11 – Resultados da determinação de elementos no vidro borato (1:5) de basalto (USGS, BIR-1).

Elemento	Concentração (mg kg^{-1})	
	Valor de referência	Este trabalho
Al	82.035	95.000 ± 11.000
Ca	95.050	64.000 ± 6.000
Ce	1,9	2 ± 1
Co	52	57 ± 3
Cr	370	490 ± 10
Fe	79.040	80.900 ± 2.700
Mn	1.350	1.290 ± 80
Ni	170	140 ± 20
Sc	44	36 ± 2
Si	224.200	263.000 ± 30.000
Sr	110	100 ± 10
V	310	350 ± 6
Y	16	20 ± 2
Zn	70	80 ± 10

Tabela A.12 – Resultados da determinação de elementos no vidro borato (1:5) de folhelho (USGS, SDO-1).

Elemento	Concentração (mg kg^{-1})	
	Valor de referência	Este trabalho
Al	64.940	99.000 ± 12.000
Ce	79	110 ± 10
Eu	1,6	1,8 ± 0,4
Fe	65.300	88.000 ± 3.000
Ga	17	21 ± 3
Ho	1,2	0,7 ± 0,1
Mn	325	440 ± 50
Ni	99	90 ± 20
P	480	640 ± 50
Rb	48	40 ± 2
Sc	13	14 ± 1
Si	230.400	420.000 ± 40.000
Sr	75	90 ± 10
Tb	1,2	1,5 ± 0,1
V	160	247 ± 5

Tabela A.13 – Resultados da determinação de elementos no vidro borato (1:5) de folhelho (USGS, SGR-1).

Elemento	Concentração (mg kg^{-1})	
	Valor de referência	Este trabalho
Al	34.510	90.000 ± 10.000
Ca	59.900	71.000 ± 6.000
Fe	21.200	43.000 ± 1.700
Gd	2,0	2,6 ± 0,2
Mn	267	490 ± 50
Sb	3,4	4,9 ± 0,4
Si	132.000	440.000 ± 43.000
V	130	310 ± 10

Tabela A.14 – Resultados da determinação de elementos no vidro borato (1:5) de folhelho (USGS, SCo-1).

Elemento	Concentração (mg kg^{-1})	
	Valor de referência	Este trabalho
Al	72.500	60.000 ± 7.000
Ba	570	480 ± 30
Ce	62	50 ± 10
Co	11	7 ± 1
Fe	35.900	22.000 ± 1.500
Ga	15	14 ± 2
K	23.000	21.000 ± 1.000
La	30	24 ± 1
Mn	410	240 ± 50
Nd	26	29 ± 2
Pb	31	20 ± 5
Pr	6,6	5,5 ± 1,0
Rb	110	99 ± 3
Sb	2,5	3,6 ± 0,3
Sc	11	6 ± 1
Si	293.600	145.000 ± 24.000
Sr	170	100 ± 10
V	130	86 ± 3
Y	26	16 ± 2
Zn	100	90 ± 10
Zr	160	123 ± 4