

## Featuring X-ray Tube Technology – No Radioactive Isotopes.

### Detection Limit Guidelines

### Low-Density Sample Types (Soils, powders, liquids)

- LOD 1% – 5%
- 250 – 2,500 ppm
- 10 – 100 ppm
- 50 – 150 ppm
- Not measured



H 1		IIA										IIIA						IVA		VA		VIA		VIIA		He 2									
0.052 Li 3		0.110 Be 4								0.185 B 5		0.282 C 6		0.392 N 7		0.525 O 8		0.677 F 9		0.851 Ne 10															
1.04 1.07 Na 11		1.25 1.30 Mg 12								1.49 1.55 Al 13		1.74 1.83 Si 14		2.02 2.14 P 15		2.31 2.48 S 16		2.62 2.82 Cl 17		2.96 3.19 Ar 18															
		III B		IV B		V B		VI B		VII B		Group VIII		I B		II B																			
3.31 3.59 K 19		3.69 4.01 Ca 20		4.09 4.46 Sc 21		4.51 4.93 Ti 22		4.85 5.43 V 23		5.41 5.43 Cr 24		5.90 6.49 Mn 25		6.40 7.06 Fe 26		6.93 7.65 Co 27		7.48 8.26 Ni 28		8.05 8.90 Cu 29		8.64 9.57 Zn 30		9.25 10.26 Ga 31		9.89 10.98 Ge 32		10.54 11.73 As 33		11.22 12.50 Se 34		11.52 13.29 Br 35		12.65 14.11 Kr 36	
13.39 14.96 Rb 37		14.16 15.83 Sr 38		14.96 16.74 Y 39		15.77 17.67 Zr 40		16.01 18.02 Nb 41		17.40 19.61 Mo 42		18.41 19.61 Tc 43		19.28 21.96 Ru 44		20.21 22.72 Rh 45		21.18 23.02 Pd 46		22.16 24.94 Ag 47		23.17 26.09 Cd 48		24.21 27.27 In 49		25.27 28.48 Sn 50		26.36 29.72 Sb 51		27.47 30.99 Te 52		28.61 32.29 I 53		29.80 33.64 Xe 54	
1.69 1.75		1.81 1.87		1.92 2.00		2.04 2.12		2.17 2.26		2.29 2.40		2.42 2.54		2.56 2.69		2.70 2.83		2.84 2.99		2.98 3.15		3.13 3.32		3.29 3.49		3.44 3.66		3.61 3.84		3.77 4.03		3.94 4.22		4.11 4.42	
30.97 34.98 Cs 55		32.19 36.36 Ba 56				55.76 63.21 Hf 72		57.52 65.21 Ta 73		59.31 67.23 W 74		61.13 69.30 Re 75		62.90 71.40 Os 76		64.80 73.55 Ir 77		66.82 75.74 Pt 78		68.79 77.97 Au 79		70.82 80.28 Hg 80		72.86 82.56 Tl 81		74.96 84.92 Pb 82		77.10 87.34 Bi 83		79.30 89.81 Po 84		81.53 92.32 At 85		83.80 94.88 Rn 86	
4.29 4.62		4.47 4.83				7.90 9.02		8.15 9.34		8.40 9.67		8.65 10.01		8.91 10.25		9.19 10.71		9.44 11.07		9.71 11.44		9.99 11.82		10.27 12.21		10.55 12.61		10.84 13.02		11.13 13.44		11.42 13.87		11.72 14.32	
86.12 97.48 Fr 87		88.46 100.34 Ra 88																																	
12.03 14.77		12.34 15.23																																	

Lanthanides 57-71		33.44 37.83 La 57		34.72 39.26 Ce 58		36.02 40.75 Pr 59		37.36 42.27 Nd 60		38.65 43.96 Pm 61		40.12 45.40 Sm 62		41.53 47.03 Eu 63		42.98 48.72 Gd 64		44.47 50.39 Tb 65		45.99 52.18 Dy 66		47.53 53.93 Ho 67		49.10 55.89 Er 68		50.73 57.90 Tm 69		52.36 59.35 Yb 70		54.06 61.28 Lu 71	
		4.05 5.04		4.84 5.25		5.03 5.49		5.23 5.72		5.43 5.96		5.64 6.21		5.85 6.46		6.06 6.71		6.28 6.98		6.50 7.25		6.72 7.53		6.95 7.81		7.18 8.10		7.41 8.40		7.65 8.71	
Actinides 89-103		90.89 102.85 Ac 89		93.33 105.59 Th 90		95.85 108.41 Pa 91		98.43 111.29 U 92		101.00 114.18 Np 93		103.65 117.15 Pu 94		106.35 120.16 Am 95		109.10 123.24 Cm 96		111.90 126.36 Bk 97		114.75 129.54 Cf 98		117.65 132.78 Es 99		120.60 138.06 Fm 100		Md 101		No 102		Lr 103	
		12.65 15.71		12.97 16.20		13.29 16.70		13.61 17.22		13.95 17.74		14.28 18.28		14.62 18.83		14.96 19.30		15.31 19.97		15.68 20.58		16.02 21.17		16.38 21.79							

Interference-free detection limits are intended as guidelines; please contact **Innov-X systems** to discuss your specific application.

Detection limits are estimates based on 1–2 minute test times and detection confidence of 3σ (99.7% confidence). Detection limits are a function of testing time, sample matrix and presence of interfering elements.

# Photon energies, in electron volts, of principal K- and L-shell emission lines.

Element	K $\alpha_1$	K $\alpha_2$	K $\beta_1$	L $\alpha_1$	L $\beta_1$
3 Li	0.05	0	0	0	0
4 Be	0.11	0	0	0	0
5 B	0.18	0	0	0	0
6 C	0.28	0	0	0	0
7 N	0.39	0	0	0	0
8 O	0.52	0	0	0	0
9 F	0.68	0	0	0	0
10 Ne	0.85	0.85	0	0	0
11 Na	1.04	1.04	1.07	0	0
12 Mg	1.25	1.25	1.3	0	0
13 Al	1.49	1.49	1.56	0	0
14 Si	1.74	1.74	1.84	0	0
15 P	2.01	2.01	2.14	0	0
16 S	2.31	2.31	2.46	0	0
17 Cl	2.62	2.62	2.82	0	0
18 Ar	2.96	2.96	3.19	0	0
19 K	3.31	3.31	3.59	0	0
20 Ca	3.69	3.69	4.01	0.34	0.34
21 Sc	4.09	4.09	4.46	0.4	0.4
22 Ti	4.51	4.5	4.93	0.45	0.46
23 V	4.95	4.94	5.43	0.51	0.52
24 Cr	5.41	5.41	5.95	0.57	0.58
25 Mn	5.9	5.89	6.49	0.64	0.65
26 Fe	6.4	6.39	7.06	0.71	0.72
27 Co	6.93	6.92	7.65	0.78	0.79
28 Ni	7.48	7.46	8.26	0.85	0.87
29 Cu	8.05	8.03	8.91	0.93	0.95
30 Zn	8.64	8.62	9.57	1.01	1.03
31 Ga	9.25	9.22	10.26	1.1	1.12
32 Ge	9.89	9.86	10.98	1.19	1.22
33 As	10.54	10.51	11.73	1.28	1.32
34 Se	11.22	11.18	12.5	1.38	1.42
35 Br	11.92	11.88	13.29	1.48	1.53
36 Kr	12.65	12.6	14.11	1.59	1.64
37 Rb	13.4	13.34	14.96	1.69	1.75
38 Sr	14.17	14.1	15.84	1.81	1.87
39 Y	14.96	14.88	16.74	1.92	2
40 Zr	15.78	15.69	17.67	2.04	2.12
41 Nb	16.62	16.52	18.62	2.17	2.26
42 Mo	17.48	17.37	19.61	2.29	2.39
43 Tc	18.37	18.25	20.62	2.42	2.54
44 Ru	19.28	19.15	21.66	2.56	2.68
45 Rh	20.22	20.07	22.72	2.7	2.83
46 Pd	21.18	21.02	23.82	2.84	2.99
47 Ag	22.16	21.99	24.94	2.98	3.15

Element	K $\alpha_1$	K $\alpha_2$	K $\beta_1$	L $\alpha_1$	L $\beta_1$
48 Cd	23.17	22.98	26.1	3.13	3.32
49 In	24.21	24	27.28	3.29	3.49
50 Sn	25.27	25.04	28.49	3.44	3.66
51 Sb	26.36	26.11	29.73	3.6	3.84
52 Te	27.47	27.2	31	3.77	4.03
53 I	28.61	28.32	32.29	3.94	4.22
54 Xe	29.78	29.46	33.62	4.11	
55 Cs	30.97	30.63	34.99	4.29	4.62
56 Ba	32.19	31.82	36.38	4.47	4.83
57 La	33.44	33.03	37.8	4.65	5.04
58 Ce	34.72	34.28	39.26	4.84	5.26
59 Pr	36.03	35.55	40.75	5.03	5.49
60 Nd	37.36	36.85	42.27	5.23	5.72
61 Pm	38.72	38.17	43.83	5.43	5.96
62 Sm	40.12	39.52	45.41	5.64	6.21
63 Eu	41.54	40.9	47.04	5.85	6.46
64 Gd	43	42.31	48.7	6.06	6.71
65 Tb	44.48	43.74	50.38	6.27	6.98
66 Dy	46	45.21	52.12	6.5	7.25
67 Ho	47.55	46.7	53.88	6.72	7.53
68 Er	49.13	48.22	55.68	6.95	7.81
69 Tm	50.74	49.77	57.52	7.18	8.1
70 Yb	52.39	51.35	59.37	7.42	8.4
71 Lu	54.07	52.97	61.28	7.66	8.71
72 Hf	55.79	54.61	63.23	7.9	9.02
73 Ta	57.53	56.28	65.22	8.15	9.34
74 W	59.32	57.98	67.24	8.4	9.67
75 Re	61.14	59.72	69.31	8.65	10.01
76 Os	63	61.49	71.41	8.91	10.36
77 Ir	64.9	63.29	73.56	9.18	10.71
78 Pt	66.83	65.11	75.75	9.44	11.07
79 Au	68.8	66.99	77.98	9.71	11.44
80 Hg	70.82	68.9	80.25	9.99	11.82
81 Tl	72.87	70.83	82.58	10.27	12.21
82 Pb	74.97	72.8	84.94	10.55	12.61
83 Bi	77.11	74.81	87.34	10.84	13.02
84 Po	79.29	76.86	89.8	11.13	13.45
85 At	81.52	78.95	92.3	11.43	13.88
86 Rn	83.78	81.07	94.87	11.73	14.32
87 Fr	86.1	83.23	97.47	12.03	14.77
88 Ra	88.47	85.43	100.13	12.34	15.24
89 Ac	90.88	87.67	102.85	12.65	15.71
90 Th	93.35	89.95	105.61	12.97	16.2
91 Pa	95.87	92.29	108.43	13.29	16.7
92 U	98.44	94.67	111.3	13.61	17.22