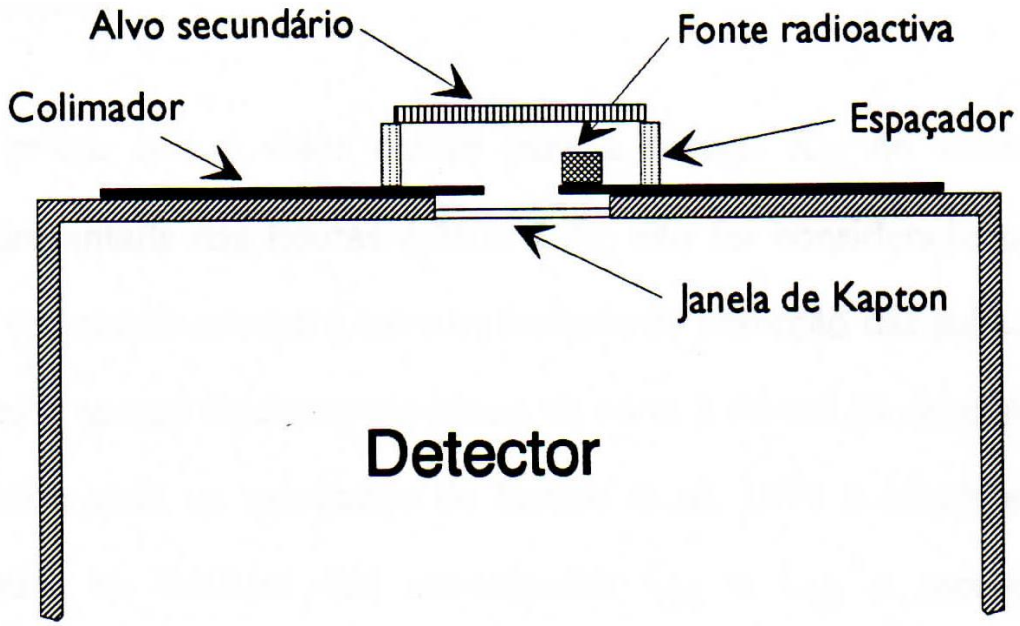
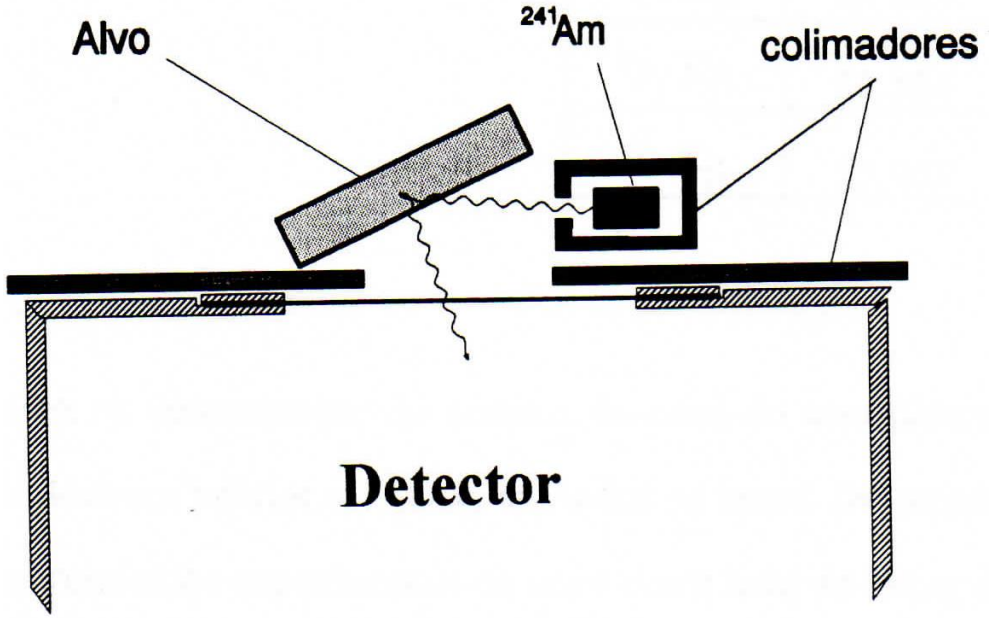
X-ray fluorescence spectrometry

Cristina M.B. Monteiro

Univ. Coimbra

Exciting source-target-detector geometries





X-ray energies

Elemento	Energia do raio X (keV)
Si $K_{\alpha,\beta}$	1,74
S $K_{\alpha,\beta}$	2,31
Cl $K_{\alpha,\beta}$	2,62
K K_{α}	3,31
Ca K_{α}	3,69
Ti K_{α}	4,51

Elemento	Energia do raio X (keV)
Cr K_{α}	5,41
MN K_{α}	5,89
Fe K_{α}	6,40
Ni K_{α}	7,47
Cu K_{α}	8,04
W L_{α}	8,40
Zn K_{α}	8,63
Pb L_{α}	10,55

Element line	X-ray en
Cu K_{α}	8.041
Zn K_{α}	8.631
Cu K_{β}	8.904
Ga K_{α}	9.244
Zn K_{β}	9.571
Ge K_{α}	9.876
Ga K_{β}	10.263
As K_{α}	10.532
Ge K_{β}	10.981
Se K_{α}	11.210
As K_{β}	11.725
Br K_{α}	11.907
Se K_{β}	12.495
Br K_{β}	13.290
Rb K_{α}	13.375
Sr K_{α}	14.142

elemento	Energia do raio X
Nb K_{α}	16.584
Nb K_{β}	18.647
Cd K_{α}	23.109
Sn K_{α}	25.193
Cd K_{β}	26.143
I K_{α}	28.512
Sn K_{β}	28.601
Cs K_{α}	30.854
Ba K_{α}	32.065
La K_{α}	33.302

elemento	Energia do raio X
Cs K_{β}	35.149
Pr K_{α}	35.864
Ba K_{β}	36.553
Nb K_{α}	37.185
La K_{β}	37.986
Ce K_{β}	39.453
Sm K_{α}	39.914
Pr K_{β}	40.953
Nd K_{β}	42.484
Gd K_{α}	42.761
Sm K_{β}	45.649
Dy K_{α}	45.728
Er K_{α}	48.818

X-ray fluorescence yield

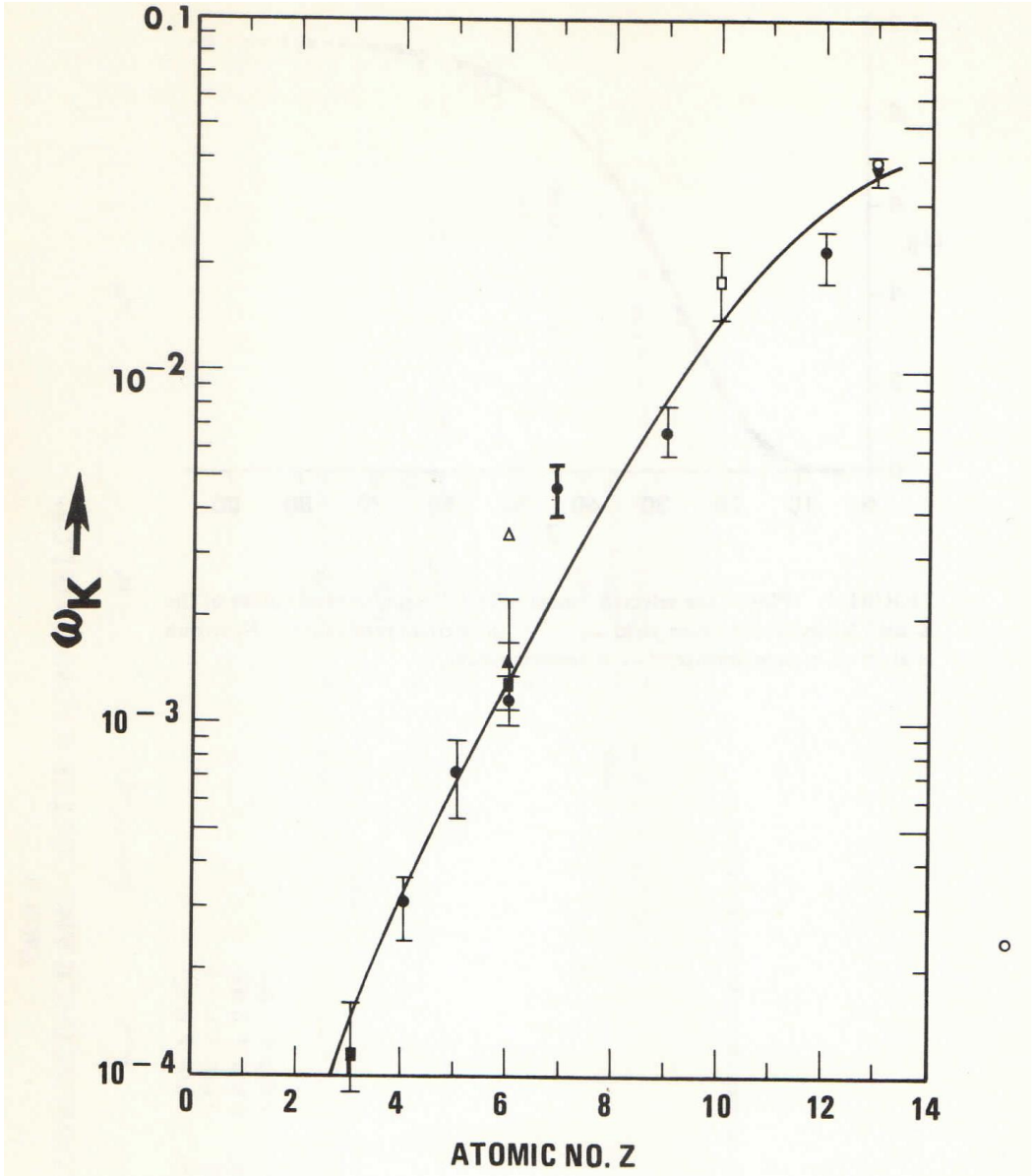


FIGURE 2. Semilog plot of low-Z K X-ray fluorescence yields based on Table 1. These yields must be used with care owing to possible large chemical and physical state effects (see discussion in the text).

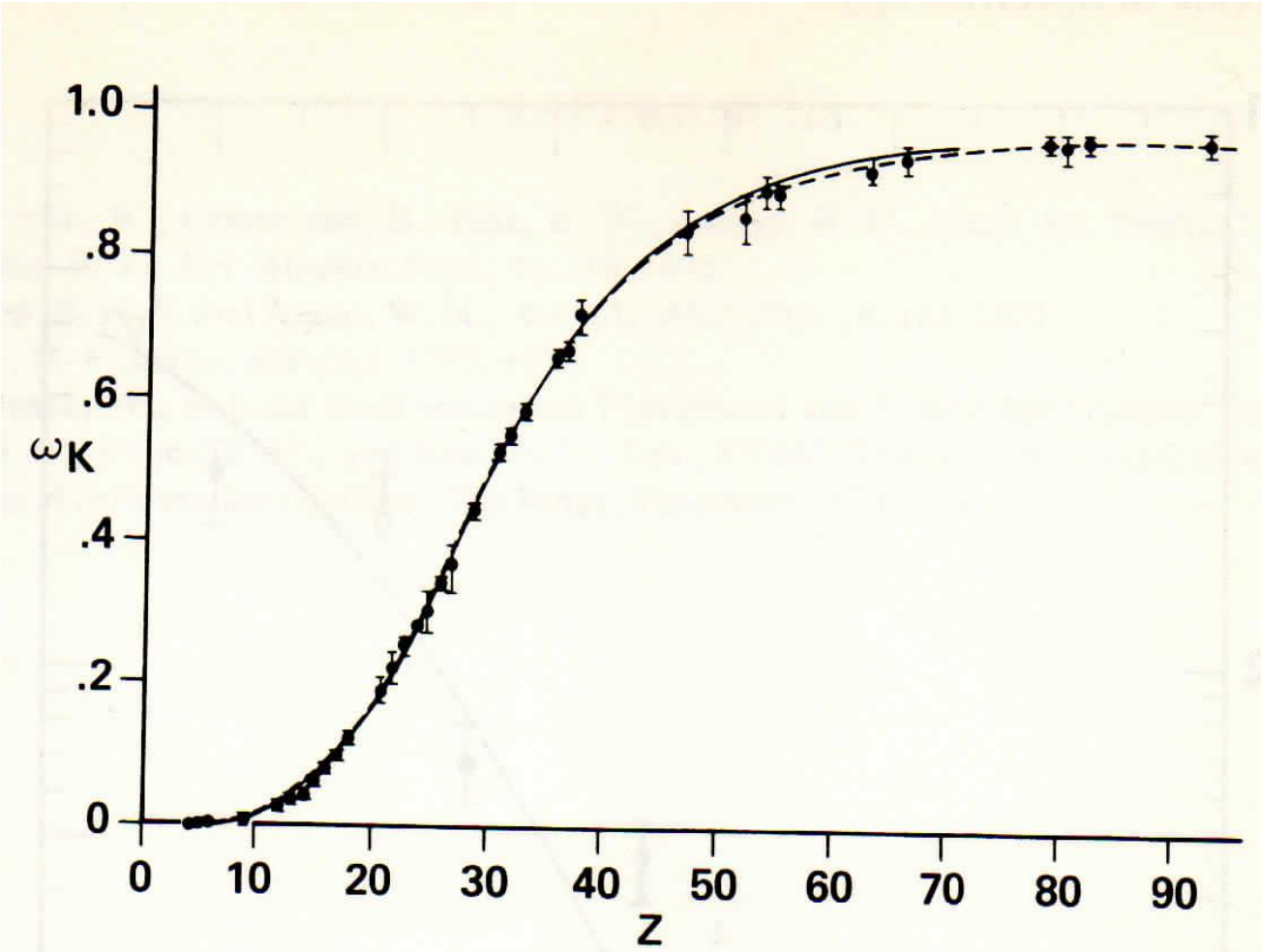


FIGURE 1. Plot of the selected "most reliable" experimental values of the K-shell X-ray fluorescence yield ω_K: — = theoretical prediction of Kostroun et al.,[46] ∓ = experiments;[1,4] --- = semiempirical.[1]

X-ray fluorescence spectra (in Xe)

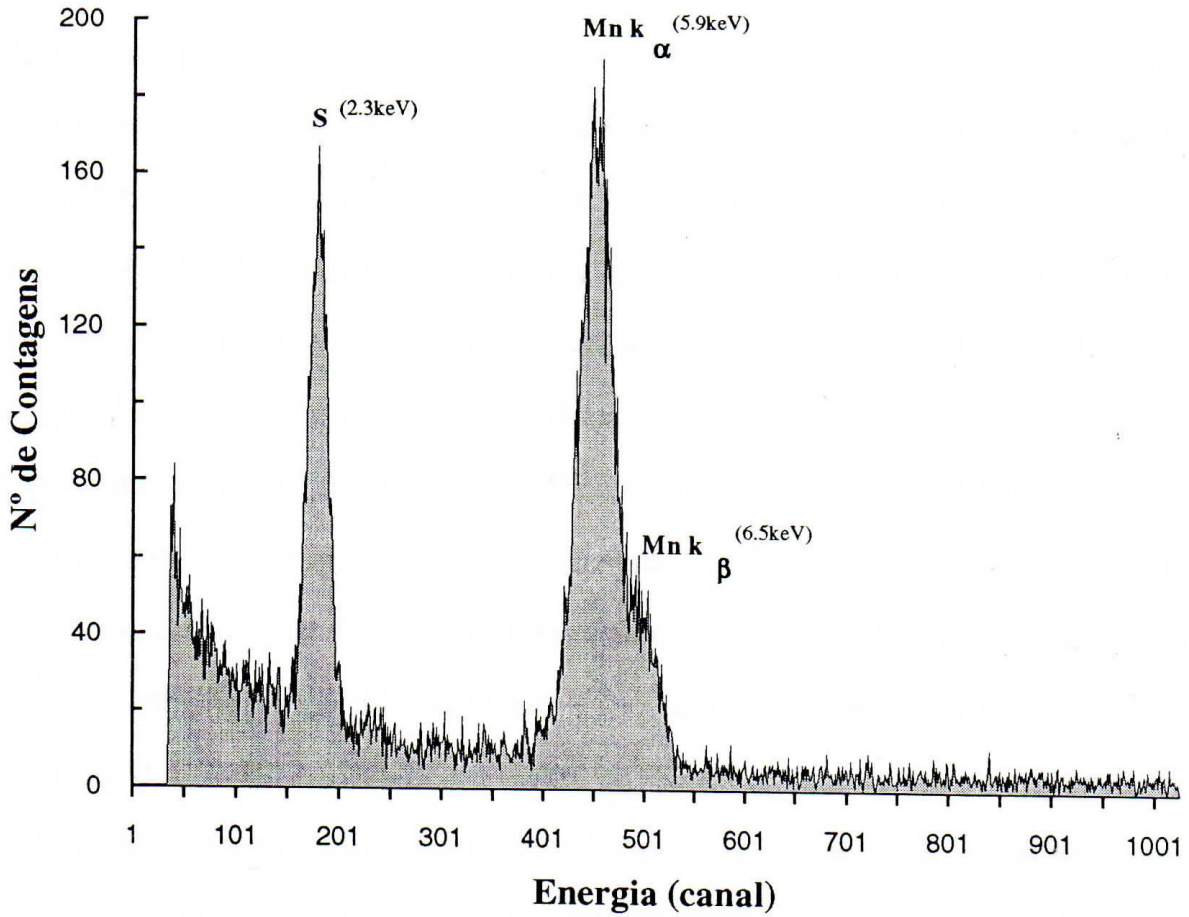


Fig.3.2-Espectro do enxofre obtido por fluorescência de raios X de uma fonte de ^{55}Fe (5,9 keV) e janela de 10 mm. O pico S corresponde às camadas K_α e K_β de enxofre enquanto que Mn $K_{\alpha,\beta}$ são picos devidos a alguns fotões da fonte de ferro terem sofrido uma difusão coerente.

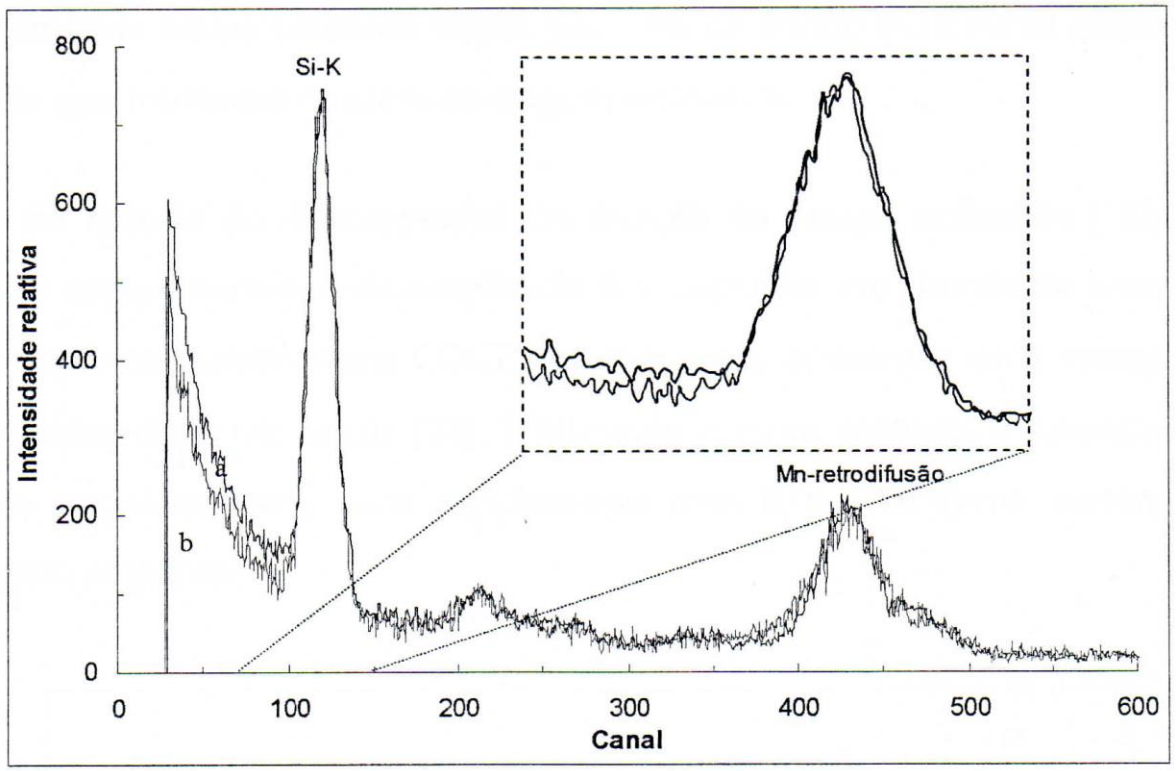


Figura 28: Distribuição de amplitudes obtidas do CGCP sem zona de deriva para a fluorescência do Si: a) usando constantes de formatação curtas sem mais correcções; b) usando constantes de formatação longas sem mais correcções

Different Kapton thicknesses of radiation window (absorption)

X-ray fluorescence spectra (in Xe)

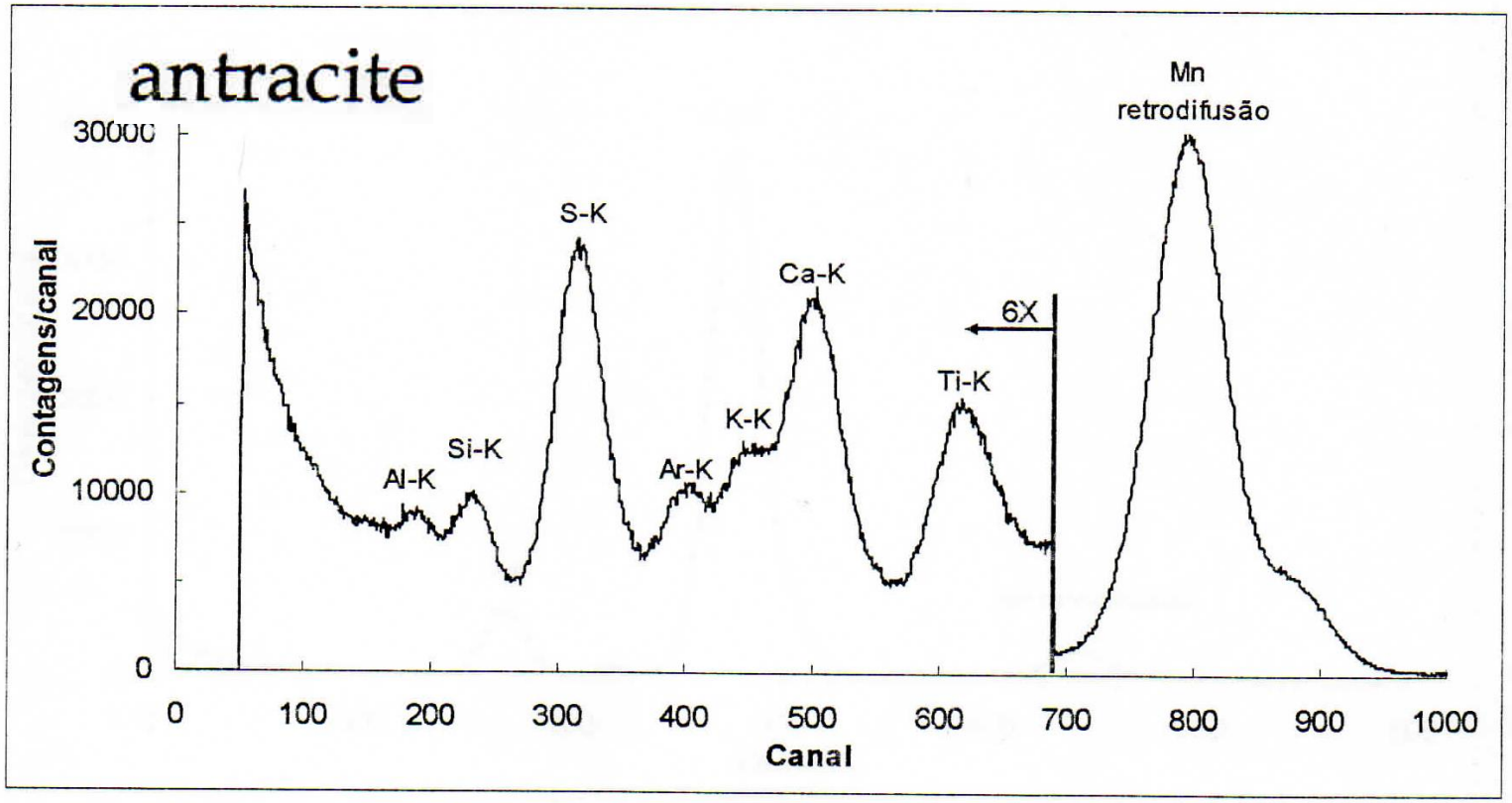


Figura 32: Espectro de fluorescência de uma amostra de antracite excitada com uma fonte de ^{55}Fe

(0.23% Na_2O, 0.11% MgO, 1.27% AlO_2, 2.47% SiO_2, 0.58% S, 0.11% K_2O,

0.11% CaO, 0.06% TiO_2, 0.25% Fe_2O_3)

X-ray fluorescence spectra (in Xe)

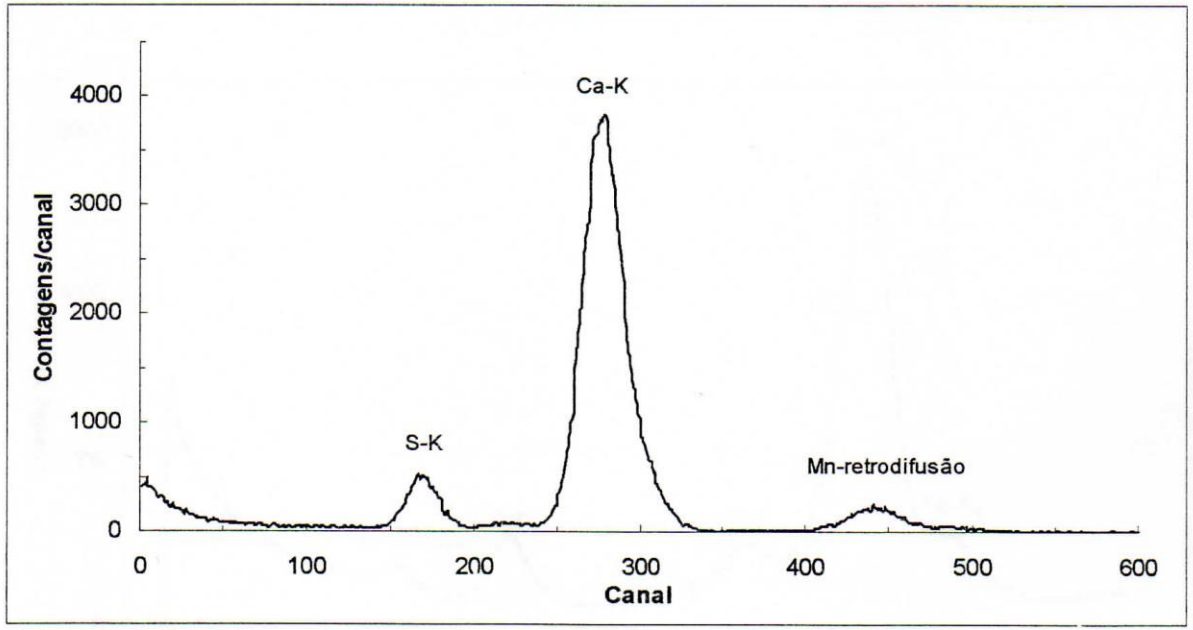


Figura33: Espectro de fluorescência de uma amostra de gesso excitada com uma fonte de ^{55}Fe

gesso ($CaSO_4$)

biotite

$K(MgFe)_3(AlSiO_{10})(OH)_2$

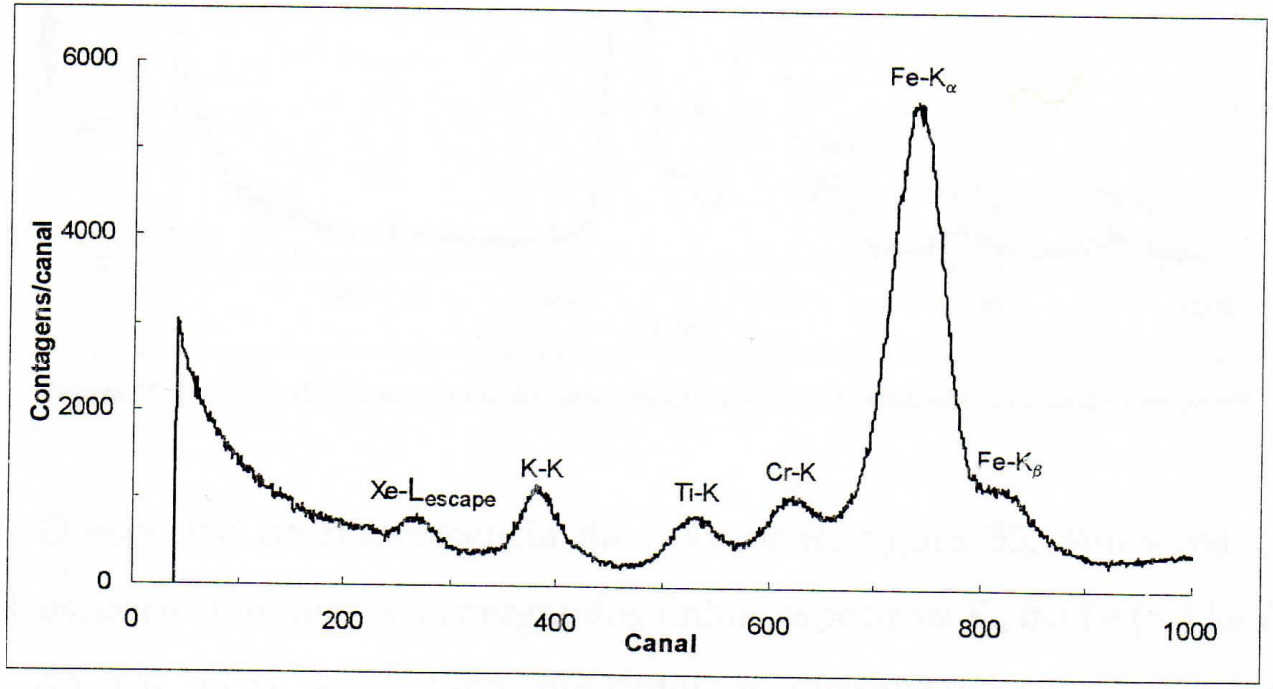


Figura 34: Espectro de fluorescência de uma amostra de biotite excitada com uma fonte de ^{109}Cd

X-ray fluorescence spectra (in Xe)

calcopirite ($CuFeS_2$).

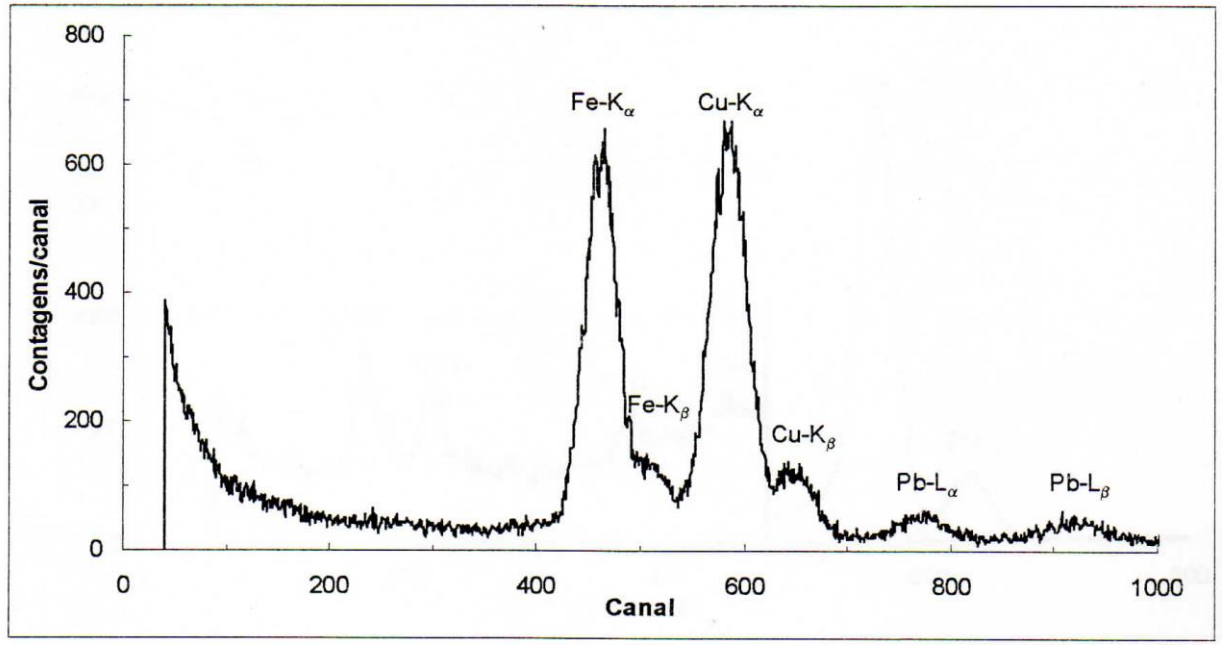


Figura 35: Espectro de fluorescência de uma amostra calcopirite excitada com uma fonte de ^{109}Cd

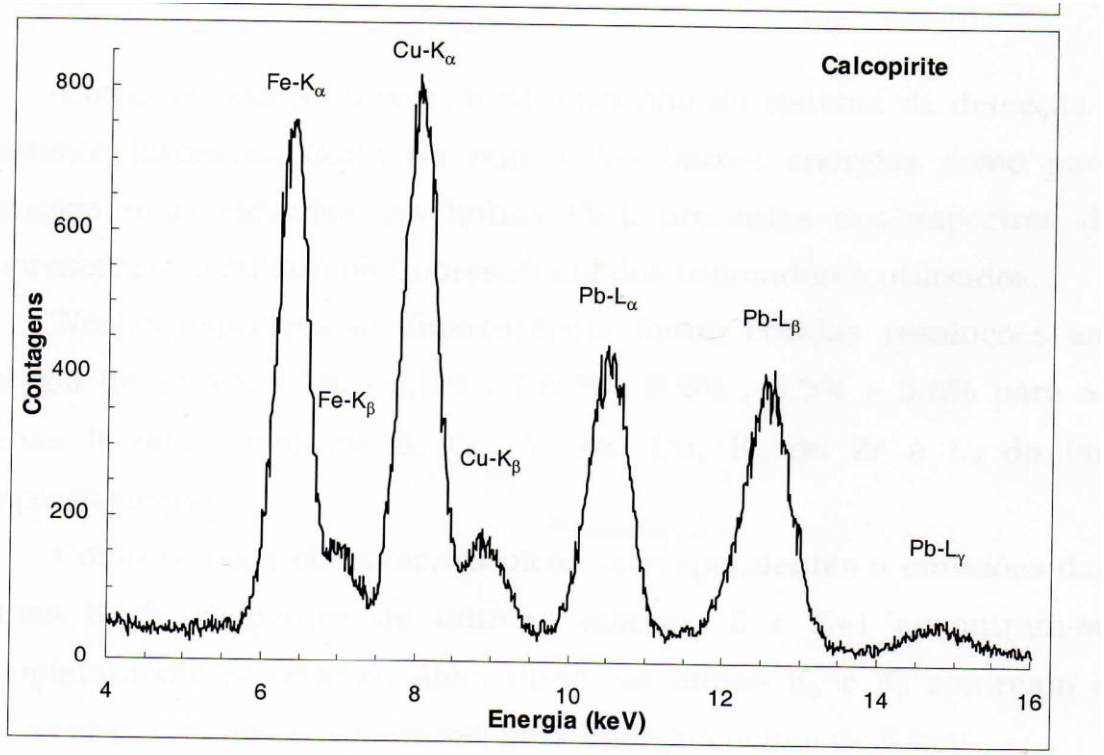


Figura 44: Espectros de fluorescência de uma amostra geológica de antracite excitada com uma fonte de ^{55}Fe e uma outra de calcopirite excita com ^{109}Cd.

Pb – collimators

X-ray fluorescence spectra (in Xe)

getters SAES St 707

(70% Zr, 5.4% Fe, 24% V)

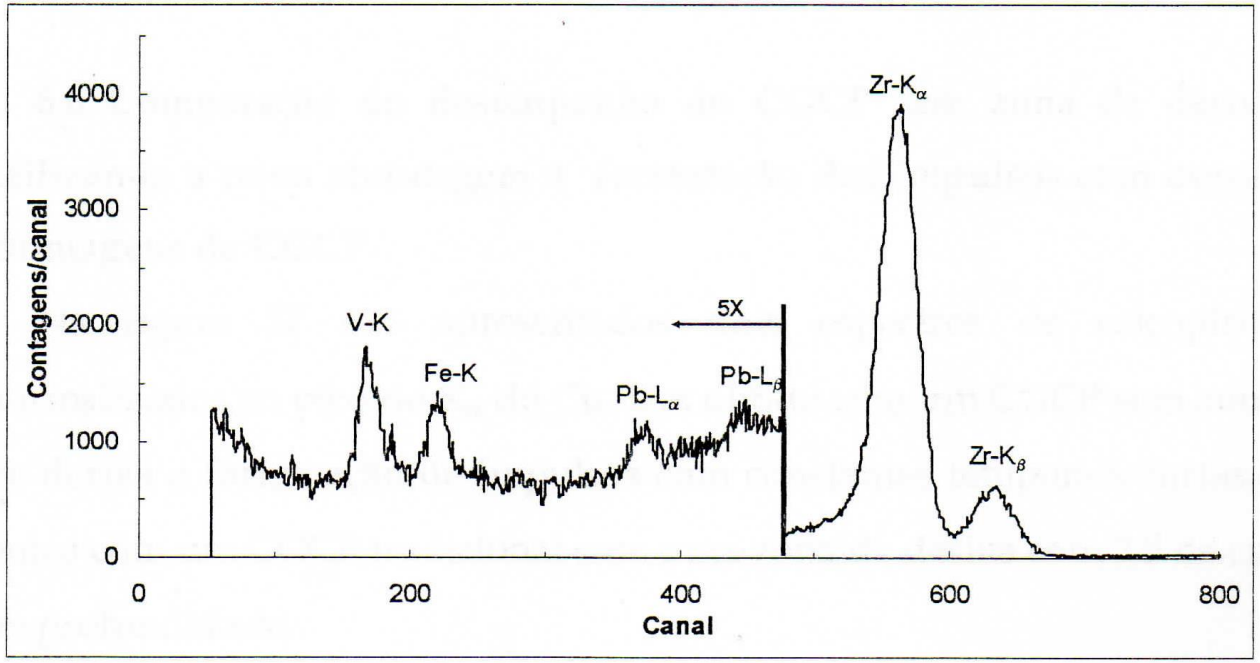
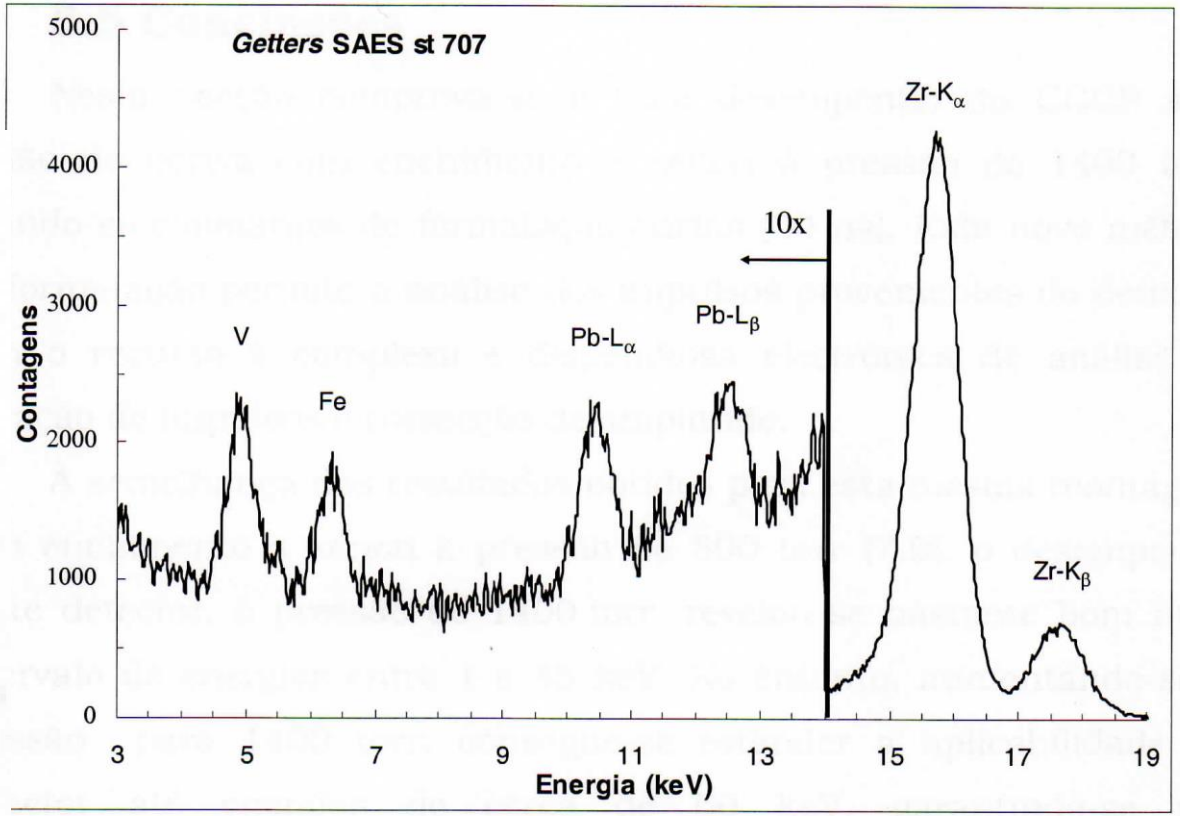


Figura 36: Espectro de fluorescência das *getters* SAES St 707 [25] excitadas com uma fonte de ^{109}Cd



ıra 45: Espectro de fluorescência de *Getters* SAES St 707 excitadas com uma fonte ^{109}Cd

Excitation x-ray sources

- 55Fe – up to Vanadium (absorption k-edge 5.5 keV)
- 109Cd – up to Ruthenium (absorption k-edge 22.12 keV)
- 241Am – up to Thulium (absorption k-edge 59.4 keV)
- But: all sources can excite L-shell of higher-Z elements)

Mass absorption efficiencies of excited elements

- **[Attenuation coefficient/density] - μ/ρ (in cm^2/g)**

Element	keV	C	F	Xe
Al	1.5	710	2000	4000
S	2.3	200	600	4000
K	3.3	61	217	800
Ti	4.5	26	88	269
Mn	5.9	11	39	658
Ni	7.5	5.2	28	356
Ge	9.9	2.1	8	169
Si	14.2	0.64	2.6	64
Mo	17.5	0.32	1.3	36
Ag	22.2	0.14	0.61	18.5
Sm	25.3	0.09	0.40	129
Ba	32.2	0.04	0.18	6.6