

## Chapter 4

### RESULTS

The accuracy of the entire procedure for determination of radionuclides was calibrated and checked by analysis of standard reference materials obtained from the International Atomic Energy Agency (IAEA). The specific activity of U-238 in uranium ore (IAEA/RGU-1), obtained from the data at energy peaks of its daughters and the certified value, are shown in Table 4.1. Tables 4.2 and 4.3 show the  $\alpha$  activity of Th-232 in thorium ore (IAEA/RGTh-1) and of K-40 in potassium sulfate (IAEA/RGK-1) respectively.

Table 4.4 shows the duplicate and some triplicate results obtained on lignite samples, from Mae Moh Mine, with different ash contents (17.1-68.4 %). The specific activity range of U-238, Th-232 and K-40 were found to be 5.0-36.5 Bq/kg with the average of 14.8 Bq/kg, 7.6-61.2 Bq/kg with the average of 21.2 Bq/kg and 24-687 Bq/kg with the average of 194 Bq/kg respectively.

Table 4.5 shows the results of specific activity of 4 lignite samples collected from locations other than Mae Moh Mine.

Tables 4.6 and 4.7 show the specific activity ratios of Pb-214 to Bi-214 and Ac-228 to Tl-208. Table 4.6 shows that in lignites from Mae Moh, the specific activity ratios of Pb-214 to Bi-214 range from 0.94-1.3 with the average of  $1.07 \pm 0.08$  and those of Ac-228 to Tl-208 range from 0.80-1.18 with the average of  $0.98 \pm 0.10$ .

Tables 4.8- 4.10 present the specific activities of Pb-214, Bi-214, Ac-228, Tl-208 and K-40 in samples collected at two week-

interval from 25 November to 23 December 1991. The average specific activities in lignite (with the average ash content of 41.2 %) are 17.3, 16.8, 21.8, 22.8 and 221 Bq/kg respectively. In bottom ash, the average specific activities are 48.4, 50.1, 52.6, 55.4 and 542 while in fly ash the values are 58.4, 58.8, 60.1, 61.8 and 647 Bq/kg respectively.

Tables 4.11-4.12 show the activity ratios of radionuclides in bottom ash and fly ash to lignite sample. In bottom ash, the average ratios found to be 2.8, 3.0, 2.6, 2.6 and 2.5 for Pb-214, Bi-214, Ac-228, Tl-208 and K-40 while in fly ash, they are 3.4, 3.5, 2.7, 2.8 and 2.8 respectively.

Tables 4.13-4.14 show the EF values of Pb-214, Bi-214, Tl-208, in bottom ash and fly ash samples. The average EF values of such radionuclides are 1.17, 1.21, 0.99 and 0.99 for bottom ashes and 1.15, 1.20, 0.95 and 0.93 for fly ashes.

Figure 4.1 shows the relationship between specific activity of U-238 in lignite (by counting Pb-214 and Bi-214) and ash content. In Figure 4.2, the relationship between specific activity of Th-232 in lignite (by counting Ac-228 and Tl-208) and ash content is shown.

Figure 4.3 is the plot between K-40 specific activity and ash content.

Figure 4.4 is the plot of specific activity of U-238 and Th-232 versus that of K-40.

Table 4.1 Specific Activity of U-238 in Uranium Ore (IAEA/RGU-1), Obtained from Its Daughters' Peaks at 63, 186, 352 and 609 keV, and the Certified Value.

Certified. value (Bq/g)	Measured value (Bq/g)			
	63 keV	186 keV	352 keV	609 keV
4.943±0.025	* 4.64 ±0.03	4.87 ±0.06	5.05 ±0.07	4.97 ±0.09

\* not corrected for self-absorption

Table 4.2 Specific Activity of Th-232 in Thorium Ore (IAEA/RGTh-1), Obtained from Its Daughters' Peaks at 239, 583 and 911 keV, and the Certified Value.

Certified. value (Bq/g)	Measured value (Bq/g)		
	239 keV	583 keV	911 keV
3.26±0.06	3.21 ±0.02	2.94 ±0.05	3.30 ±0.10



Table 4.3 Specific Activity of K-40 in Potassium Sulfate  
(IAEA/RGK-1), Obtained from Its Own Peak at 1461 keV  
and the Certified Value.

Certified. value (Bq/g)	<u>Measured value (Bq/g)</u> 1461 keV
30	30.2 <u>+0.1</u>

Table 4.4 Specific Activity of U-238, Th-232 and K-40 in  
Lignite Samples from Mae Moh Mine

No. of Sample	Ash %	Activity (Bq/kg)				
		Uranium series		Thorium series		Potassium
		Pb-214	Bi-214	Ac-228	Tl-208	K-40
		352 keV	609 keV	911 keV	583 keV	1461 keV
1	17.1	7.9	8.1	9.6	11.8	58.7
2	23.5	10.2	9.1	11.3	10.9	62.9
3	25.1	13.8	12.6	18.3	18.3	119
4	30.2	11.8	11.0	13.3	16.7	70
5	35.4	10.4	9.3	14.9	16.6	97
6	37.3	5.2	5.0	9.5	9.8	24
7	38.1	9.0	8.1	15.3	13.0	105
8	38.2	11.3	8.7	13.4	14.3	52
9	40.0	8.7	8.4	7.6	8.3	89
10	41.5	11.9	12.7	15.8	15.8	228
11	41.7	13.6	12.7	13.1	14.9	234
12	44.2	13.6	11.9	15.3	15.3	118
13	44.5	13.5	11.5	25.1	24.5	172
14	46.0	20.0	20.4	24.5	22.0	217
15	46.2	11.5	9.9	9.6	9.5	59

Table 4.4 (continue) Specific Activity of U-238, Th-232 and K-40 in Lignite Samples from Mae Moh Mine

No. of Sample	Ash %	Activity (Bq/kg)				
		Uranium series		Thorium series		Potassium
		Pb-214	Bi-214	Ac-228	Tl-208	K-40
		352 keV	609 keV	911 keV	583 keV	1461 keV
16	54.1	34.9	32.6	46.3	46.0	473
17	64.2	34.3	31.8	57.7	56.5	687
18	68.4	36.5	34.3	61.2	59.0	634
Average		15.4	14.3	21.2	21.3	194
Average		14.8		21.2		194
Min. value		5.0		7.6		24
Max. value		36.5		61.2		687

Table 4.5 Specific Activity of U-238, Th-232 and K-40 in Lignite Samples from Locations Other Than Mae Moh Mine

No. of Sample	Ash %	Activity (Bq/kg)				
		Uranium series		Thorium series		Potassium
		Pb-214	Bi-214	Ac-228	TL-208	K-40
		352 keV	609 keV	911 keV	583 keV	1461 keV
1	3.4	< 2	< 2	< 4	< 3	< 10
2	2.4	< 2	< 2	< 4	< 3	< 10
3	11.3	47.7	41.7	14.4	14.6	20
4	11.2	55.2	51.6	24.6	24.4	37.8



Table 4.6 Activity Ratios of Pb-214 to Bi-214 and Ac-228 to Tl-208 in Lignite Samples from Mae Moh Mine

Sample no.	Pb-214/Bi-214	Ac-228/Tl-208
1	0.98	0.81
2	1.12	1.05
3	1.10	1.0
4	1.07	0.80
5	1.30	0.93
6	1.12	0.88
7	1.11	1.18
8	1.04	0.97
9	0.94	0.97
10	1.07	0.88
11	1.04	0.92
12	1.14	1.00
13	1.17	1.12
14	1.16	1.01
15	0.98	1.11
16	1.07	1.01
17	1.08	1.02
18	1.06	1.04
Average	1.07 $\pm$ 0.08	0.98 $\pm$ 0.10



Table 4.7 Activity Ratios of Pb-214 to Bi-214 and Ac-228 to Tl-208 in Lignite Samples from Locations Other Than Mae Moh Mine

Sample no.	Pb-214/Bi-214	Ac-228/Tl-208
1	-	-
2	-	-
3	1.14	0.99
4	1.07	1.01

Table 4.8 Specific Activity of Pb-214, Bi-214, Ac-228, Tl-208 and K-40 in Lignite Samples Collected on 25 November, 9 and 23 December 1991 at Mae Moh Power Station

Sample of	Ash %	Activity (Bq/kg)				
		Pb-214	Bi-214	Ac-228	Tl-208	K-40
		352 keV	609 keV	911 keV	583 keV	1461
25 Nov. 91	44.4	16.9	17.6	21.8	21.0	228
9 Dec. 91	36.7	15.1	13.9	24.5	22.8	213
23 Dec. 91	42.4	20.0	18.8	22.2	21.5	222
Average	41.2	17.3	16.8	22.8	21.8	221

Table 4.9 Specific Activity of Pb-214, Bi-214, Ac-228, Tl-208 and K-40 in Bottom Ash Samples Collected on 25 November, 9 and 23 December 1991 at Mae Moh Power Station

Sample of	Activity (Bq/kg)				
	Pb-214	Bi-214	Ac-228	Tl-208	K-40
	352 keV	609 keV	911 keV	583 keV	1461
25 Nov. 91	44.8	49.5	58.0	47.4	560
9 Dec. 91	47.5	40.8	50.1	49.3	528
23 Dec. 91	53.0	60.0	58.2	61.1	538
Average	48.4	50.1	55.4	52.6	542

Table 4.10 Specific Activity of Pb-214, Bi-214, Ac-228, Tl-208 and K-40 in Fly Ash Samples Collected on 25 November, 9 and 23 December 1991 at Mae Moh Power Station

Sample of	Activity (Bq/kg)				
	Pb-214	Bi-214	Ac-228	Tl-208	K-40
	352 keV	609 keV	911 keV	583 keV	1461
25 Nov.91	50.5	55.1	54.8	54.1	645
9 Dec.91	56.3	53.7	62.4	57.6	665
23 Dec.91	68.3	67.6	68.2	68.8	631
Average	58.4	58.8	61.8	60.1	647



Table 4.11 Activity Ratio of Pb-214, Bi-214, Ac-228, Tl-208  
and K-40 in Bottom Ash to Those in Lignite.

Sample of	Pb-214	Bi-214	Ac-228	Tl-208	K-40
	352 keV	609 keV	911 keV	583 keV	1461 keV
25 Nov.91	2.7	2.8	2.7	2.3	2.5
9 Dec.91	3.1	2.9	2.6	2.8	2.5
23 Dec.91	2.7	3.2	2.6	2.8	2.4
Average	2.8	3.0	2.6	2.6	2.5

Table 4.12 Activity Ratio of Pb-214, Bi-214, Ac-228, Tl-208  
and K-40 in Fly Ash to Those in Lignite

Sample of	Pb-214	Bi-214	Ac-228	Tl-208	K-40
	352 keV	609 keV	911 keV	583 keV	1461 keV
25 Nov.91	3.0	3.1	2.5	2.6	2.8
9 Dec.91	3.7	3.9	2.5	2.5	3.1
23 Dec.91	3.4	3.6	3.1	3.2	2.8
Average	3.4	3.5	2.7	2.8	2.9



Table 4.13 Enrichment Factor (EF) of Pb-214, Bi-214, Ac-228  
and Tl-208 in Bottom Ash

Sample of	Pb-214	Bi-214	Ac-228	Tl-208
	352 keV	609 keV	911 keV	583 keV
25 Nov.91	1.08	1.14	1.08	0.92
9 Dce.91	1.27	1.18	0.82	0.87
23 Dec.91	1.16	1.32	1.08	1.17
Average	1.17	1.21	0.99	0.99

Table 4.14 Enrichment Factor (EF) of Pb-214, Bi-214, Ac-228  
and Tl-208 in Fly Ash.

Sample of	Pb-214	Bi-214	Ac-228	Tl-208
	352 keV	609 keV	911 keV	583 keV
25 Nov.91	1.06	1.11	0.89	0.91
9 Dce.91	1.19	1.24	0.82	0.81
23 Dec.91	1.20	1.26	1.08	1.12
Average	1.15	1.20	0.93	0.95

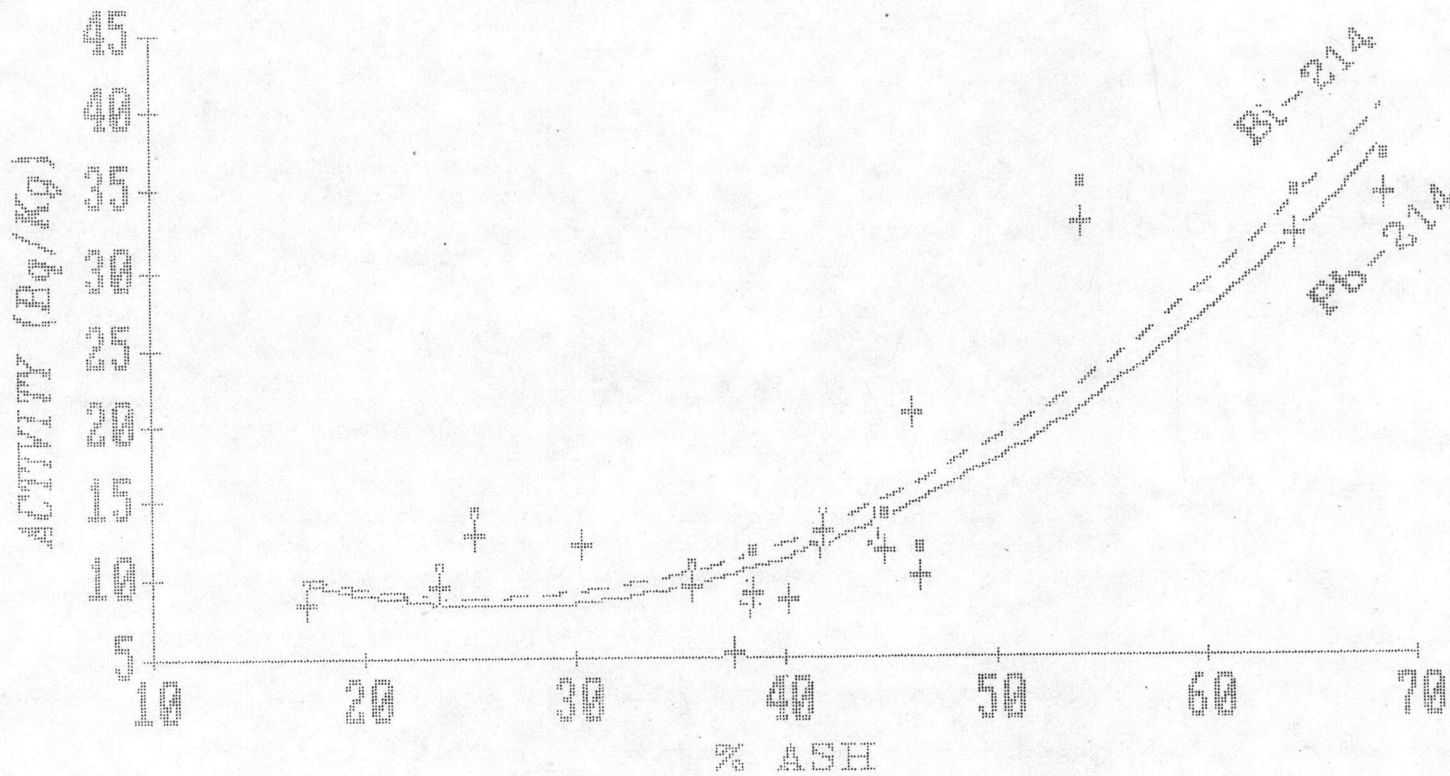


Figure 4.1 U-238 Activity in Lignite (by Counting Pb-214 and Bi-214) VS % Ash

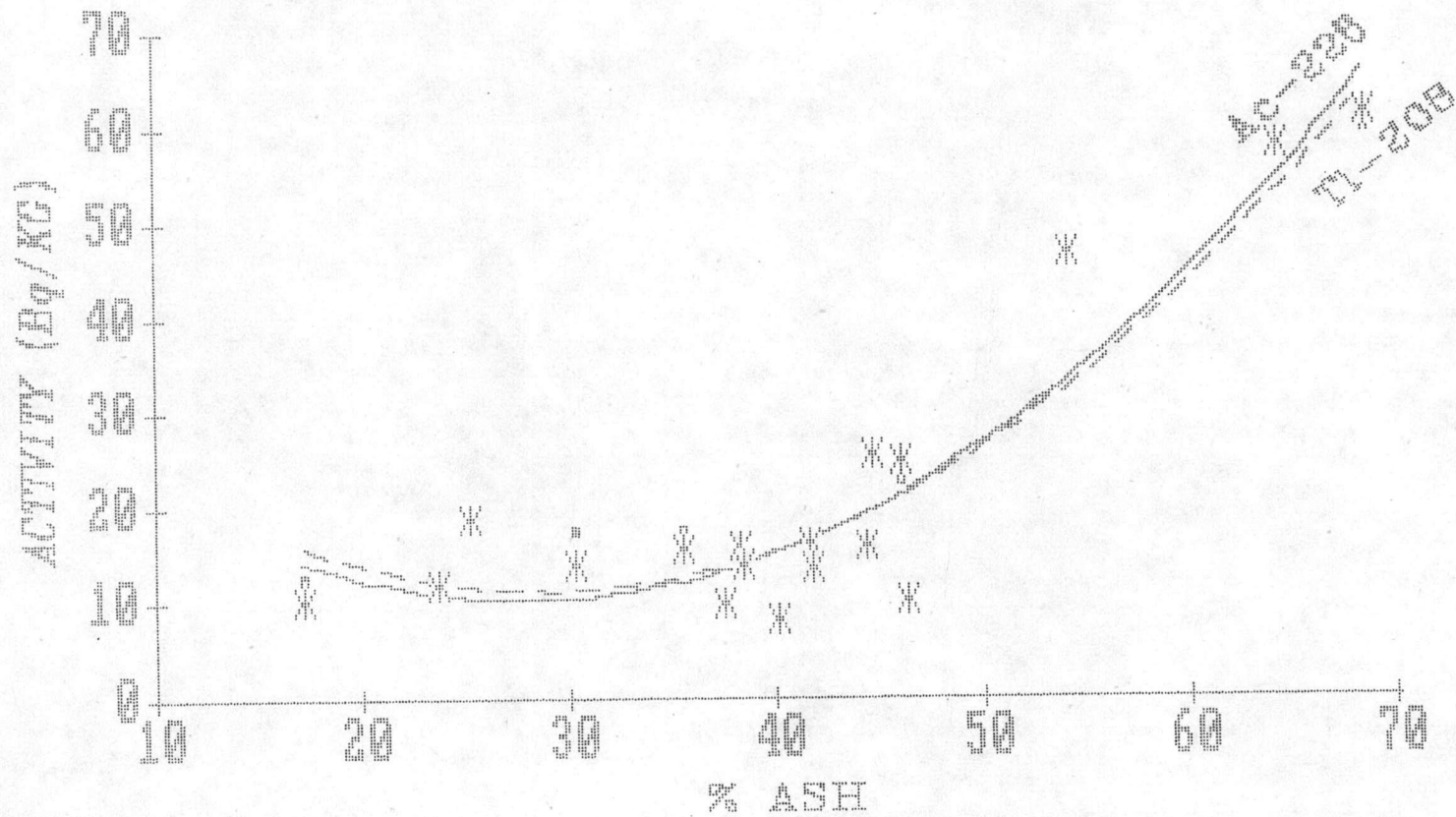


Figure 4.2 Th-232 Activity in Lignite (by Counting Ac-228 and Tl-208) VS % Ash

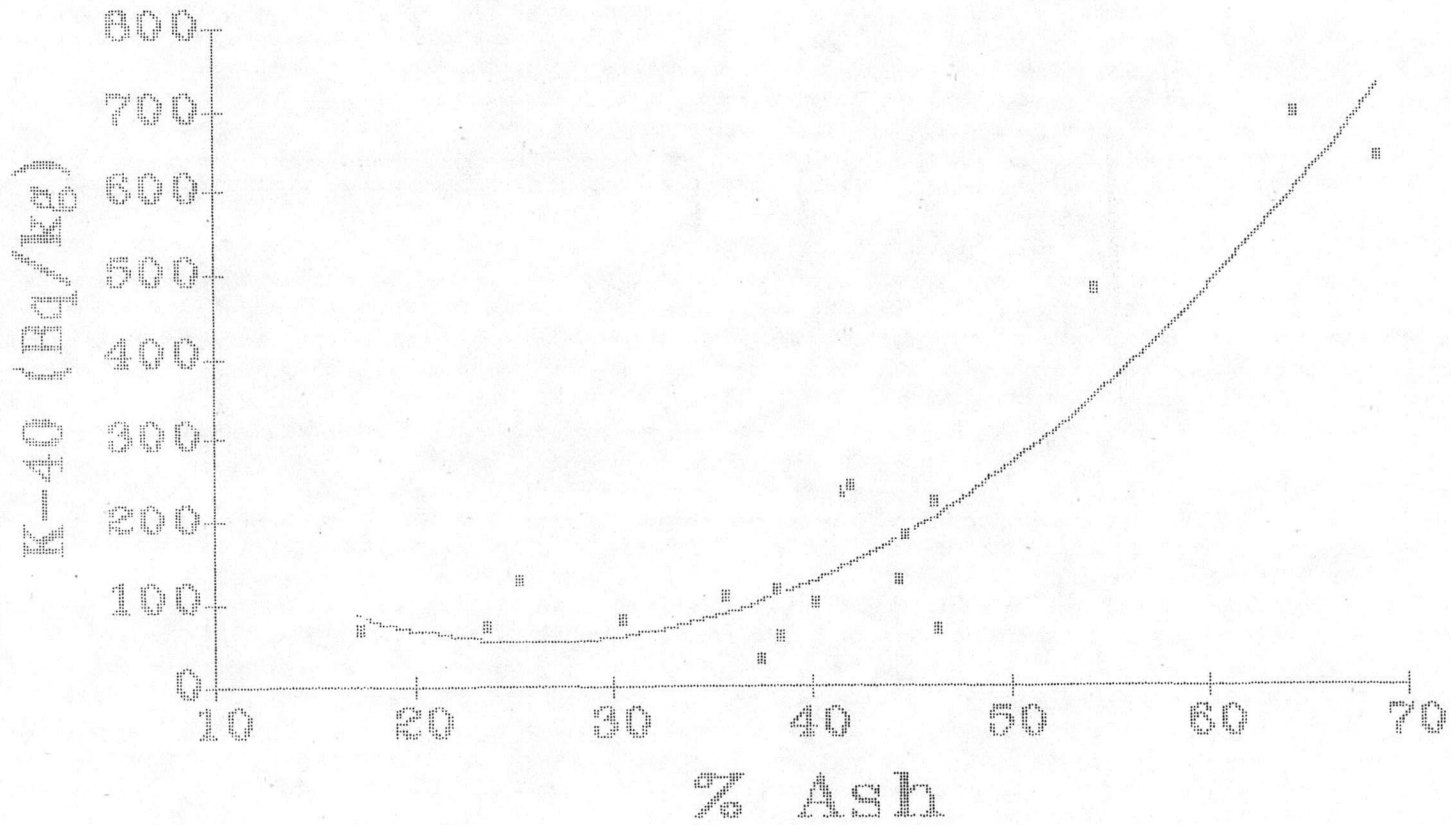


Figure 4.3 K-40 Activity in Lignite VS % ASH



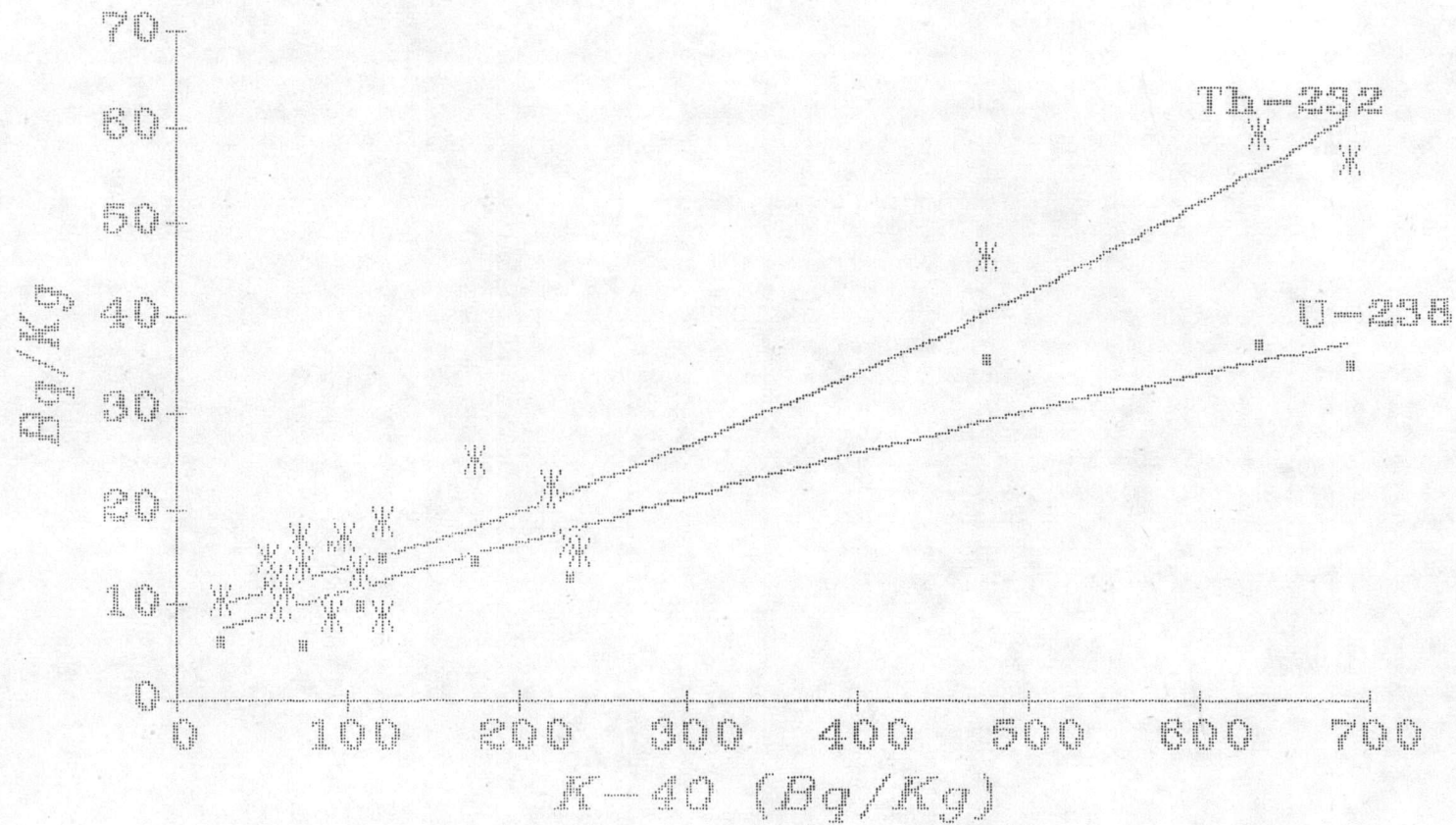


Figure 4.4 U-238 and Th-232 Activity in Lignite VS % Ash