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RADIOACTIVE FALLOUT ELEMENTS IN PLANT SAMPLES FROM VANCOUVER ISLAND

by

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MINERAL SCIENCES DIVISION

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SUMMARY OF RESULTS

Gamma-ray spectra have been obtained for thirteen plant samples from Vancouver Island submitted by Professor H.V. Warren of the University of British Columbia. Peaks due to the fission products Ce-144, Zr-95/Nb-95, Cs-137, and due to K-40 are identified. A comparison of the intensity of the 137 KeV gamma-ray in the various samples showed a higher activity for fir needles and twigs in their second year of growth than for those in their first year. The activity per unit mass of the twigs was equal to that of the needles despite a probable difference in the ratio of surface area to mass. No significant evidence was obtained for any selective uptake of these fallout isotopes in the plants examined.

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INTRODUCTION

In May, 1959 a number of plant samples of leaves, twigs, and bark collected in Western Canada, were submitted to the Mines Branch in Ottawa by Professor H.V. Warren of the University of British Columbia for analysis in the gamma-ray spectrometer. This was done in connection with his investigations into the uptake of trace elements in plants and their various parts. Indications of fallout activity such as that due to caesium-137 were found in this preliminary investigation. A second series of samples, whose spectra are described in this report was collected near Port Alberni, B.C., a region of Vancouver Island subject to an average annual precipitation of 67 inches. These spectra were taken beginning November 10, 1959 - upon receipt of the samples.

The specific activity (counts per minute per gram) of the twenty-two samples was in each case very low, requiring 25-100 grams of sample to produce a spectrum after a count of several hours. The activity from the smallest samples (0.5 g, see Table 1) was not detectable. Overnight, or week-end counting periods of 1000 to 4000 minutes were often required to produce a smooth spectrum i.e., to minimize the statistical fluctuations. In most cases the portion of the total count resulting from the sample was much less than that due to the background radiation. It was impractical to use the spectrometer for very many background determinations requiring counting periods of 1000 minutes or more so that a few unexplained peaks can be expected in the net sample spectra - particularly from samples with barely detectable activity.

The peak resulting from 285-day cerium-144 at 137 KeV was the most intense in these samples, as in previous samples taken from the atmosphere (1). The decay of this nuclide is sufficiently slow to permit its measurement several months after fission had occurred; also at this stage of decay there were no overlapping peaks as in the case of zirconium-95/niobium-95 and caesium-137 (723, 756/765 and 662 KeV).

EXPERIMENTAL RESULTS

The samples, their weights, and net specific count-rates for the peak due to Ce-144 at 137 KeV are listed in Table 1. The count rates were normalized to that of a 100 g sample so that their specific count rates could be compared. This was done with gamma-ray sources having similar energies and with absorbers of various thicknesses, having about the same density as the samples, to simulate the wide range of source geometry encountered in measuring the plant samples. The spectra are shown in Figures 1 to 14. The last figure shows the spectrum obtained from assorted leaves gathered in the Ottawa area to determine whether there is enough activity in this area to produce a spectrum. The sample geometry of the "local" leaves was greatly improved by compressing

TABLE 1

Cerium Activity in Plant Samples

Sample No.	Description of Samples	Leaves or Needles	Twigs or Reed	Year of growth (1959)	Net Weight (g)	Ce-144, 137 KeV peak intensity*
1A	Bracken (Pteridium aquilinum)		R	1	52	
1B		L		1	140	6.0
2A	Big-Leaf Maple (Acer macrophyllium)	L		1	74	14.5
2B			T	1	19	
2C			T	2	2.7	
3A	Douglas Fir (Pseudotsuga menziesii)	N		1	27	9.4
3B			T	1	15	12.4
3C			T	2	16	55
3D		N		2	10	61
4A	Grand Fir (Abies grandis)	N		1	66	7.2
4B			T	1	9	
4C			T	2	9	46
4D		N		2	16	50
5A	Red Alder (Alnus rutra)	L		1	62	16
5B			T	1	6.2	26
5C			T	2	26	30
6A	Red Osier Dogwood (Cornus stolonifera)	L		1	130	20
6B			T	1	7	
6C			T	2	13	
7A	Oregon Grape (Mahonia aquifolium)	L		1		4.9
7B			T	1	1.9	
7C			T	2	0.5	

*counts/min/100 grams calculated to Nov. 10, 1959.

a large bulky sample into a 2 in. by 2 in. cylinder by means of a hydraulic press.

The specific activities for Ce-144 compared in Table 1, have slight corrections applied, where necessary, to compensate for radioactive decay between measurements which extended over several months. It is to be noted that: (a) the highest specific activities are to be found in the coniferous products (twigs and needles) which were collected during their second year of growth, (b) these twigs and needles (Douglas Fir and Grand Fir) have the same specific activities.

DISCUSSION OF RESULTS

In a discussion with the author, Professor Warren indicated that the above results were consistent with his findings regarding the extraction from the soil by plants of certain other non-radioactive trace elements such as lead. The effect was cumulative being greater after two years of growth. The fact that the twigs and needles had the same specific activities although their ratios of surface area to volume during growth differed greatly could indicate that the radioactive fallout trace elements were derived from the soil in the process of normal plant growth rather than by a physical surface adsorption.

This conclusion, however, should be considered in the light of Ljunggren's (2) recent measurements of the activity of the various parts of a spruce tree and the surrounding soil. His examination with a Geiger counter of the ash from each sample showed a rather high activity for twigs which had been dead for several years. This activity had a similar rate of decay to that of short-lived activity in other live parts of the tree. Ljunggren found the relative radioactivity of the second-year needles to be 1.8 and the second-year twigs to be 3.6.

An estimate of the potassium-40 content was made for the leaf sample of bracken based on the yield in the spectrum (Figure 1) at 1460 KeV. The net count was compared with a similar volume of potassium chloride of known weight. The concentration of potassium for the dried leaves was calculated to be about 1%. This value varies from 0.5 to 2% for dried leaves from non-fertilized pasture land (3).

When the activities due to zirconium and its daughter element niobium have decayed sufficiently, it may be worthwhile to compare the total count rates of the samples based on the activity of the long-lived caesium nuclide. The results could then be compared with those obtained above for cerium.

REFERENCES

(1) Horwood, J.L., Geochimica et Cosmochimica Acta 19, No. 2, 85 (1960).

(2) Ljunggren, P., Nature, 186, 655 (1960).

(3) Ward, G.M., Plant Research Institute, Department of Agriculture, Ottawa (Private communication).

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JLH:DV

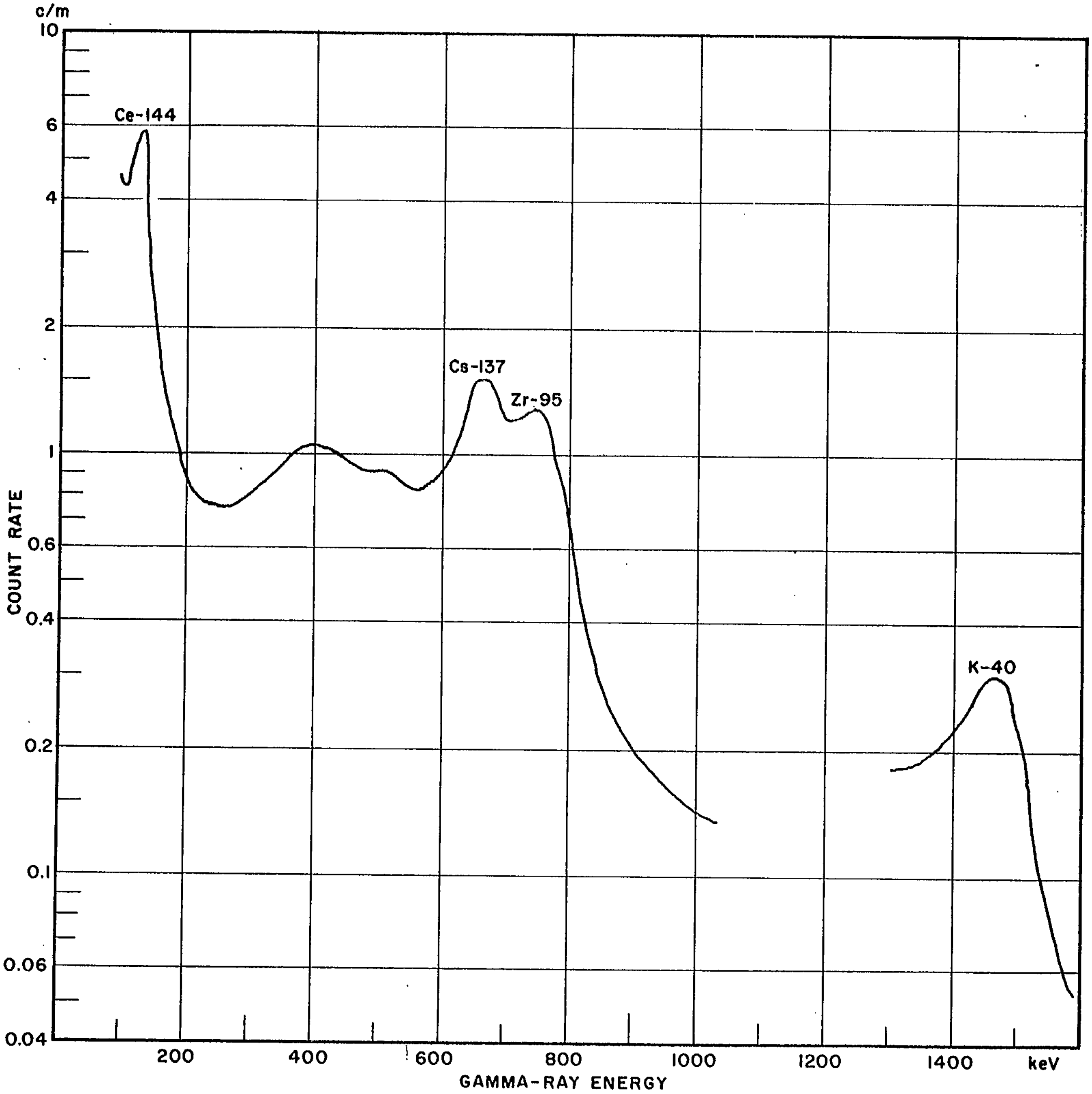

FIG.1-1B-BRACKEN LEAVES

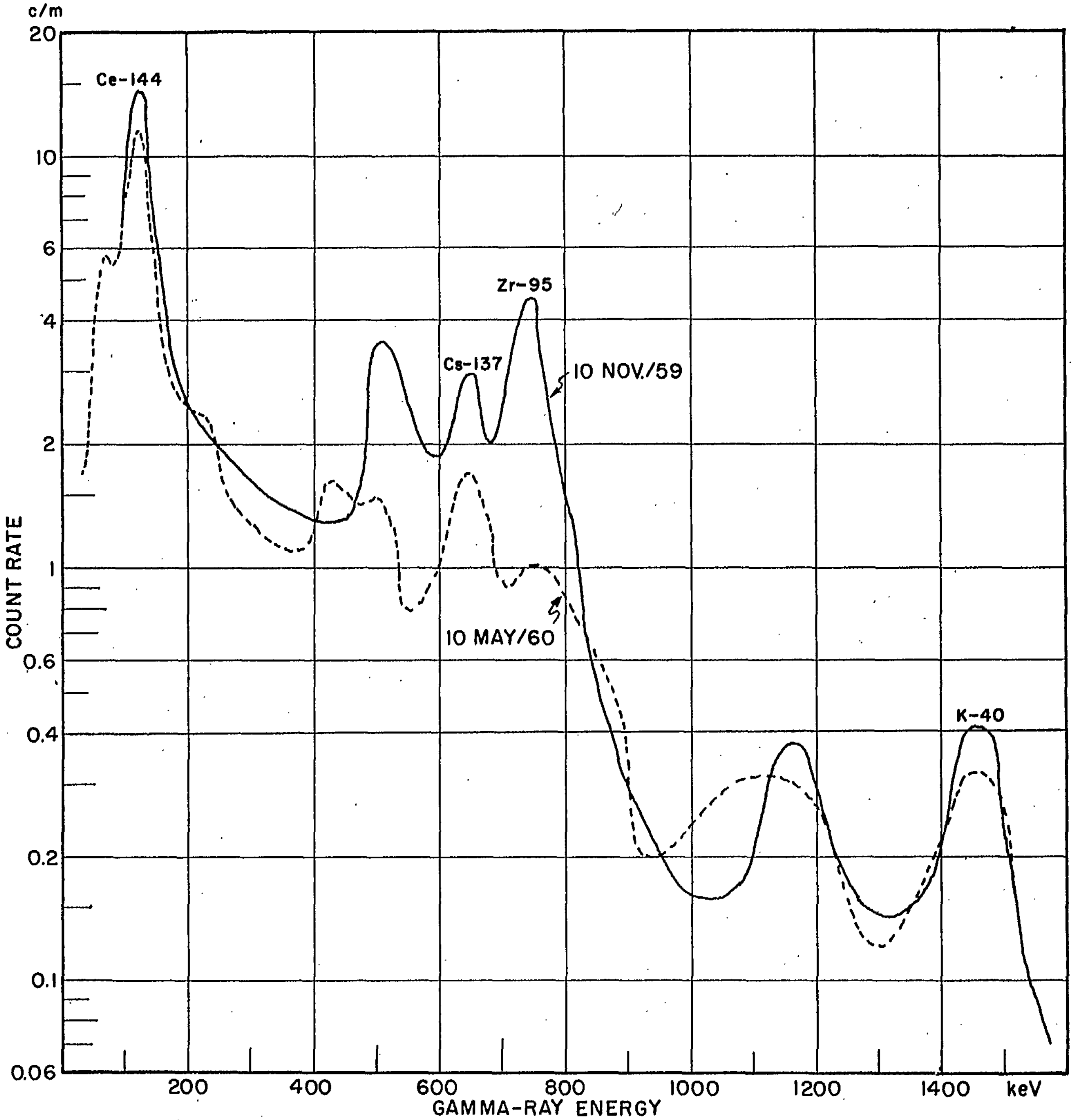

FIG. 2- 2A - BIG-LEAF MAPLE LEAVES

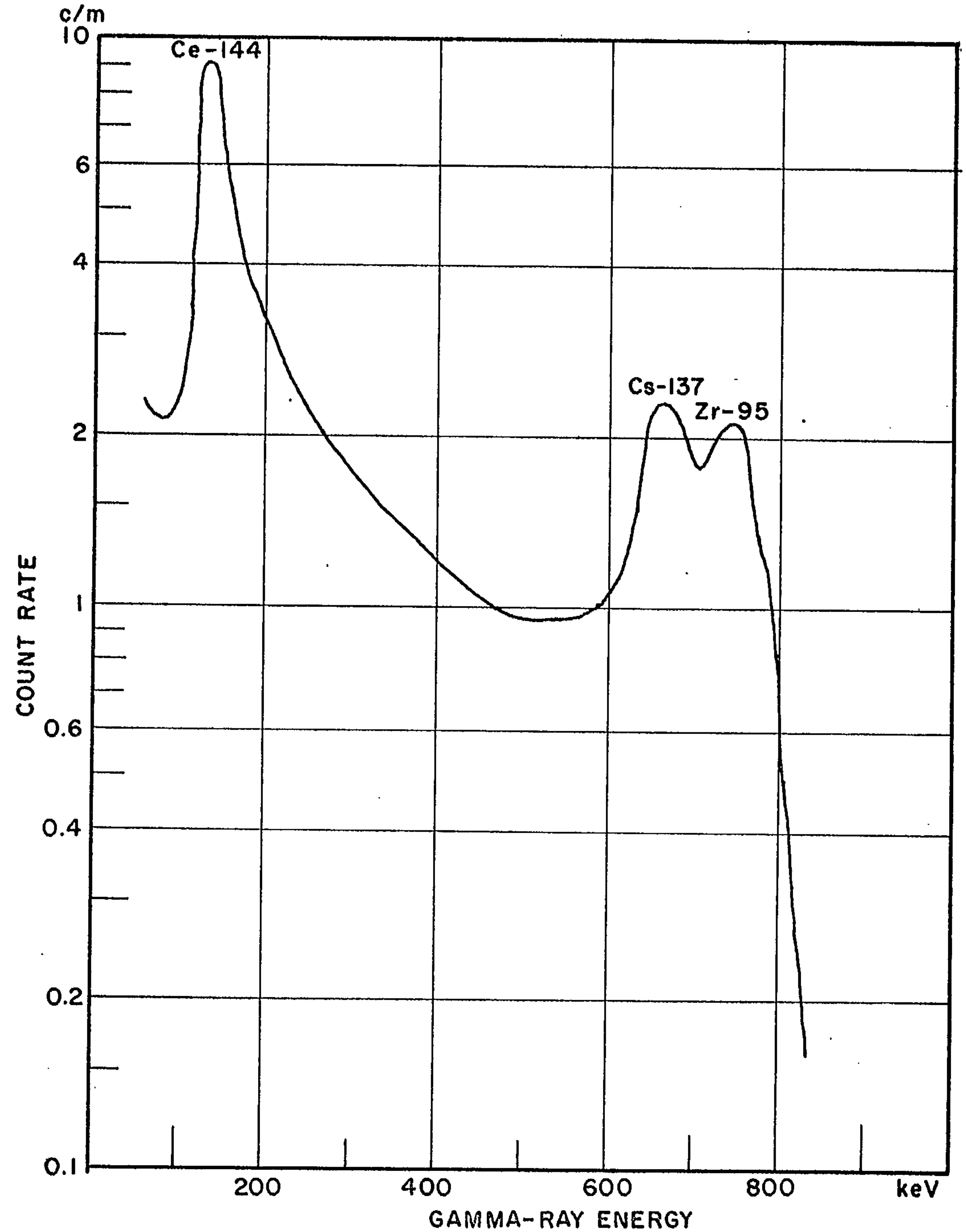

FIG. 3 - 3A - DOUGLAS FIR NEEDLES (1ST YEAR GROWTH)

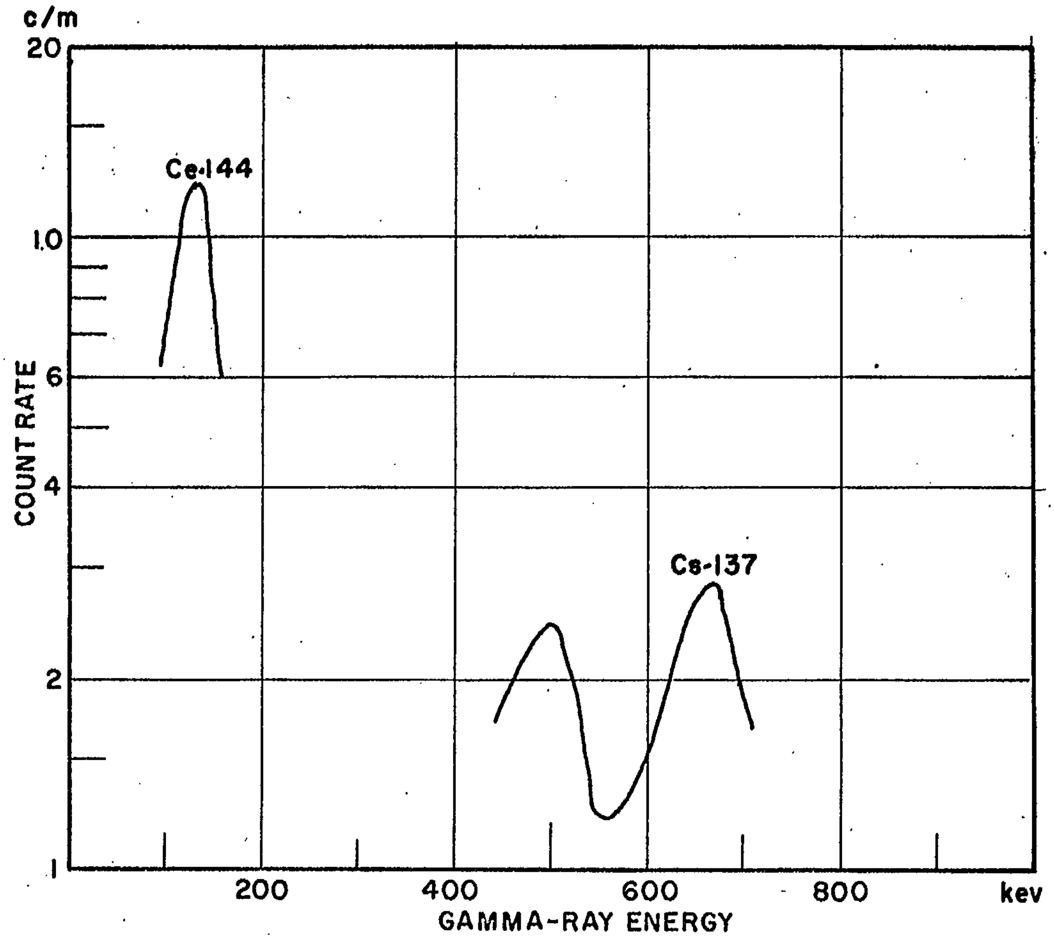

FIG. 4 - 3B - DOUGLAS FIR TWIGS (1ST YEAR GROWTH)

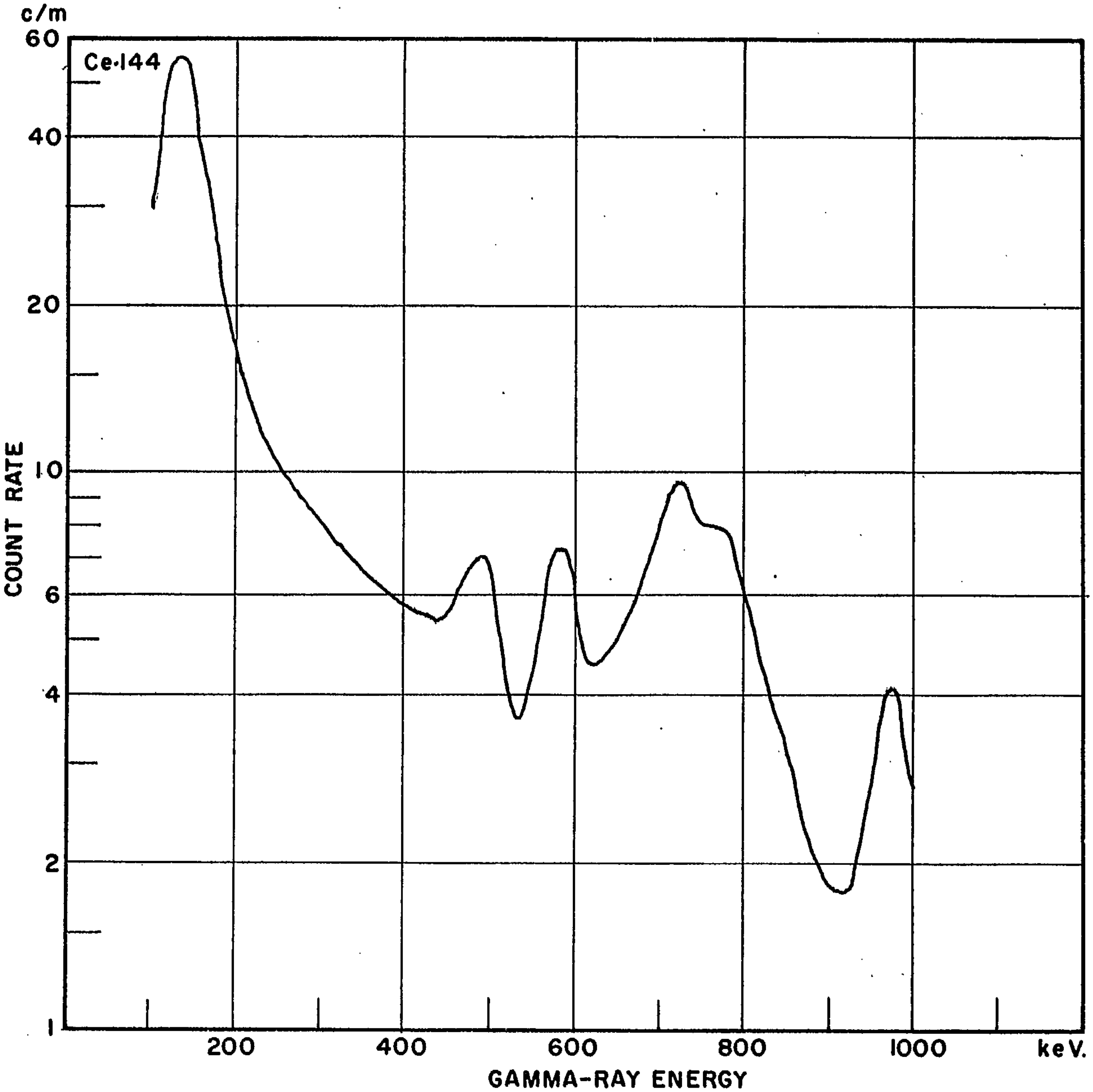

FIG. 5 - 3C-DOUGLAS FIR TWIGS (2ND YEAR GROWTH)

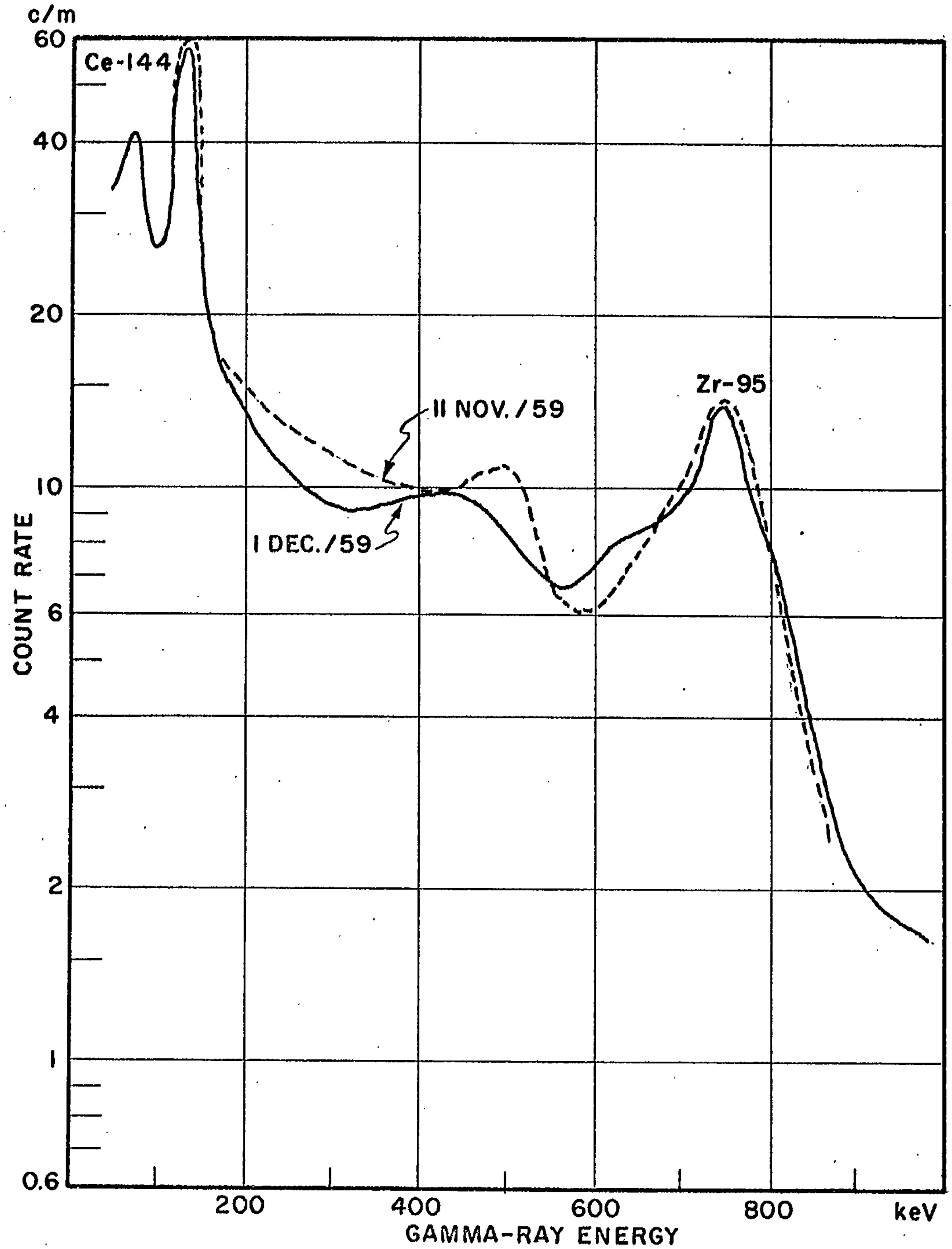

FIG. 6 – 3D-DOUGLAS FIR NEEDLES (2ND YEAR GROWTH)

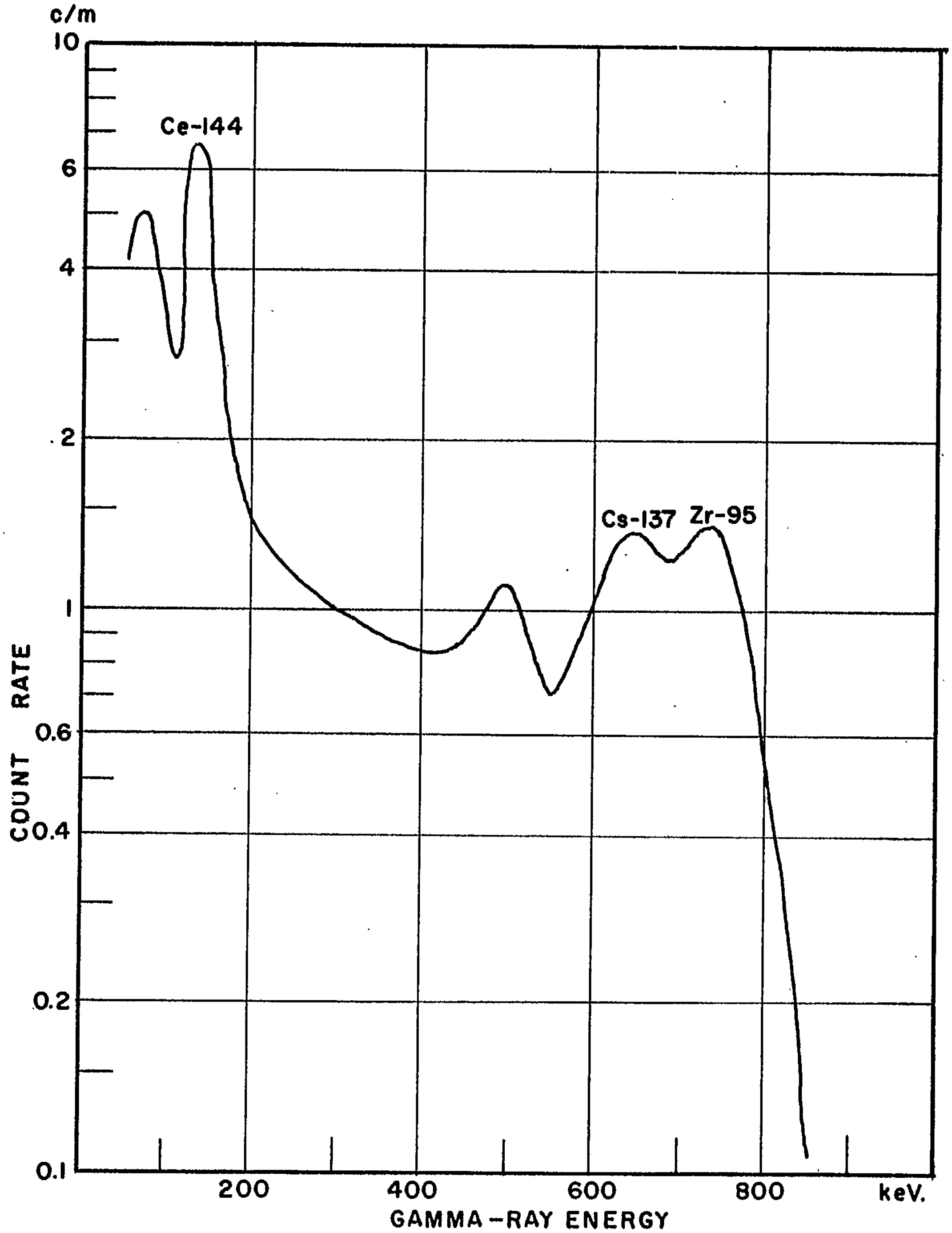

FIG. 7- 4A-GRAND FIR NEEDLES (1ST YEAR GROWTH)

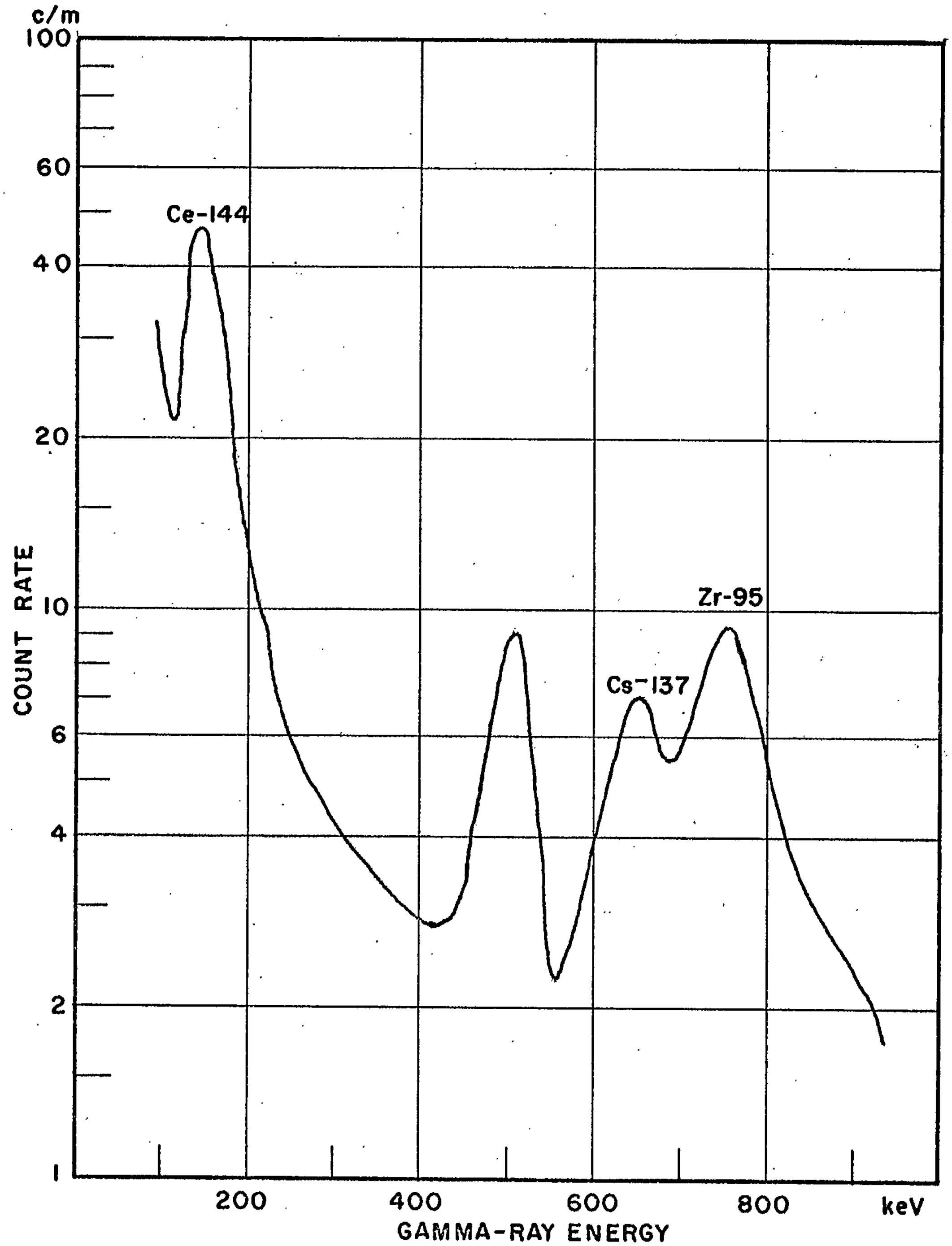

FIG. 8 - 4C-GRAND FIR TWIGS (2ND YEAR GROWTH)

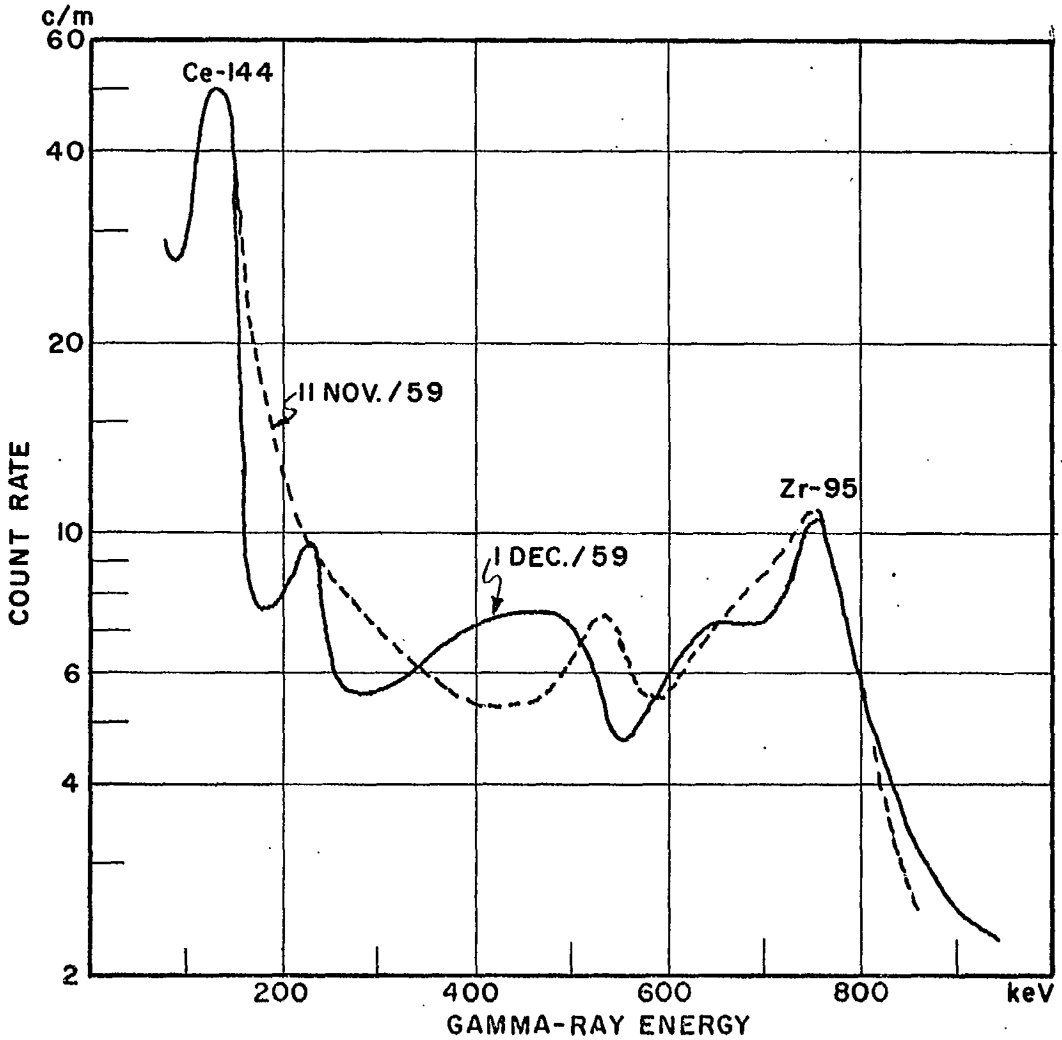

FIG. 9 - 4D-GRAND FIR NEEDLES (2ND YEAR GROWTH)

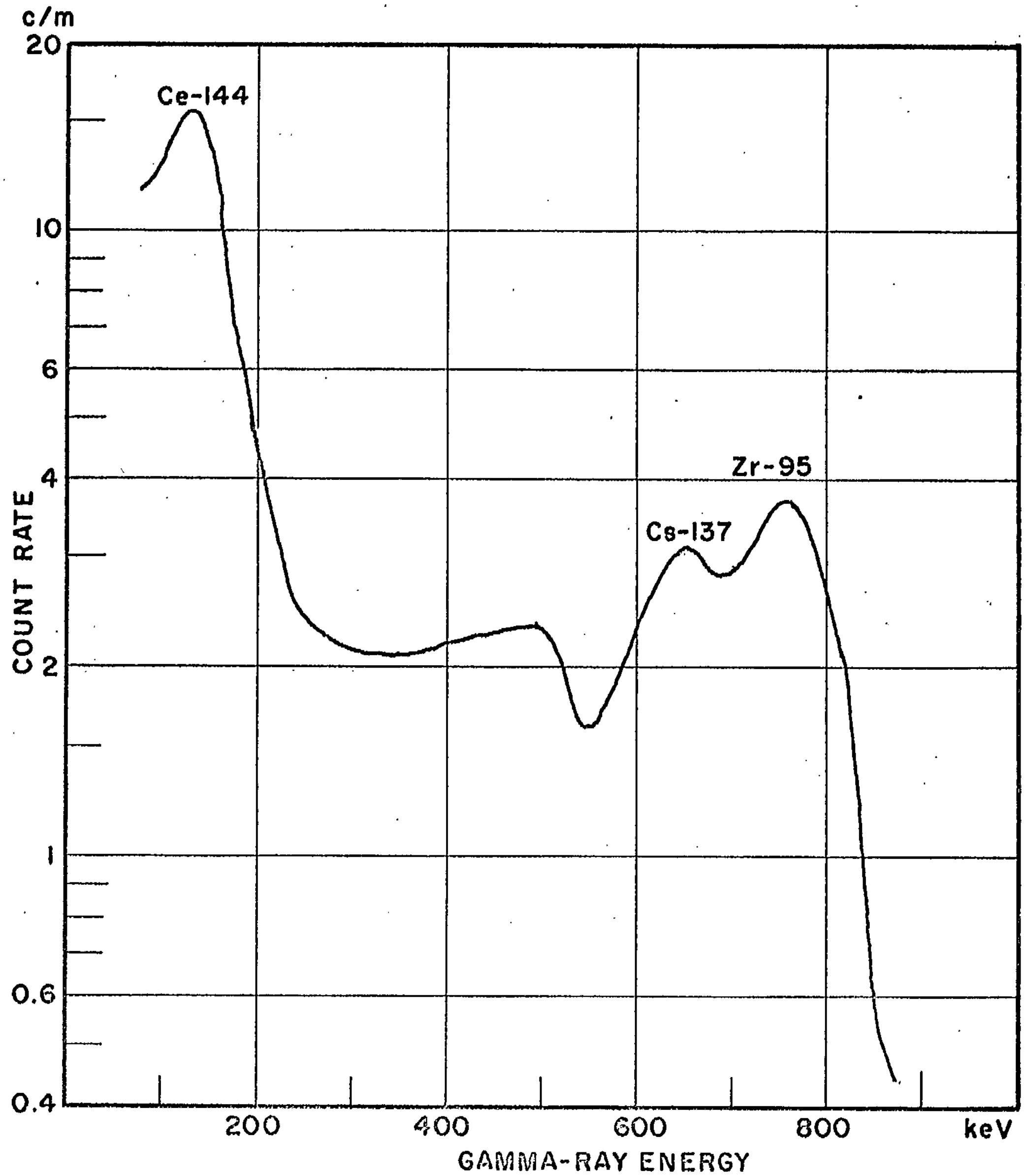

FIG. 10- 5A-RED ALDER LEAVES

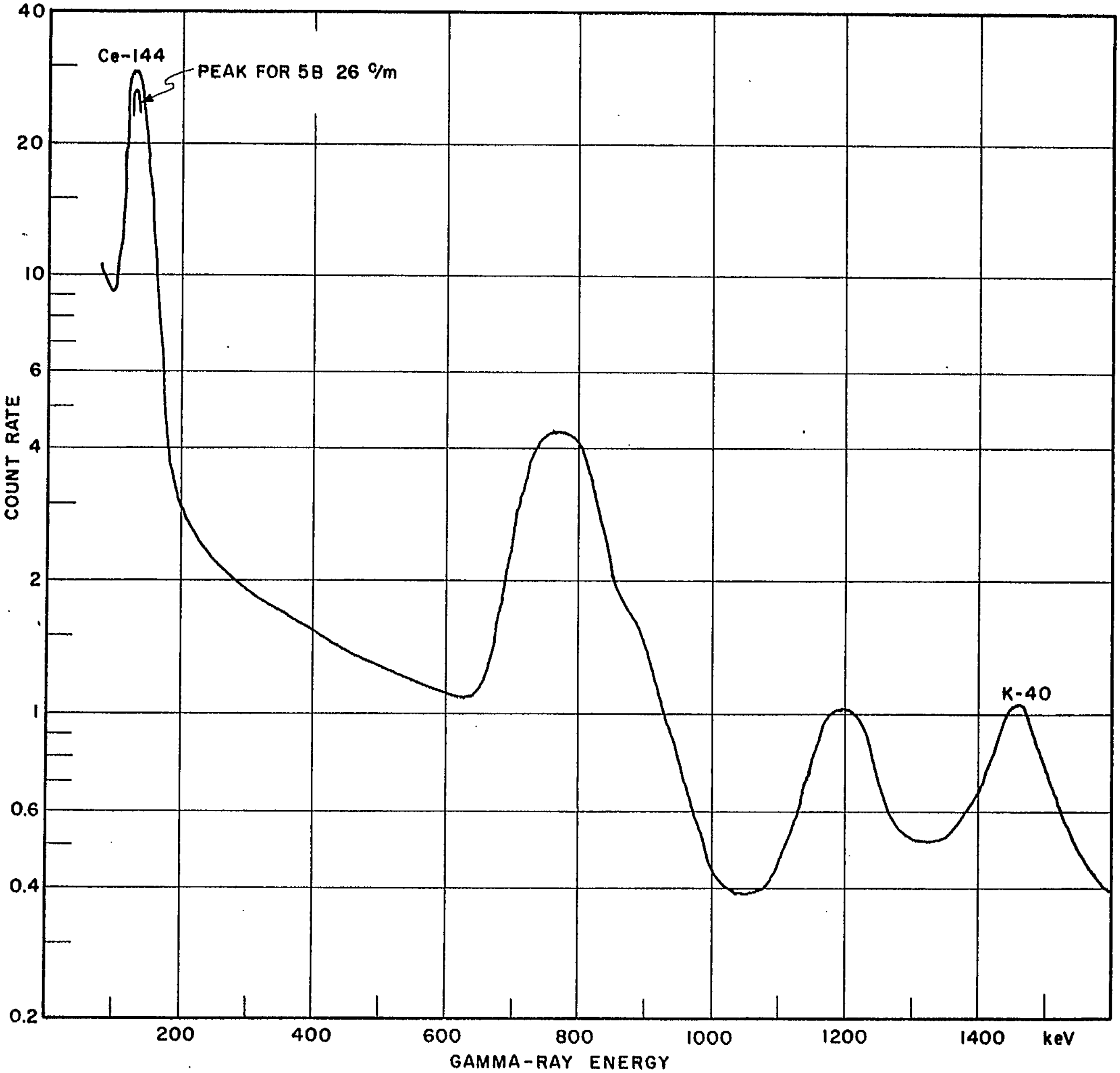

FIG.11 - 5C-RED ALDER TWIGS (2ND YEAR GROWTH)

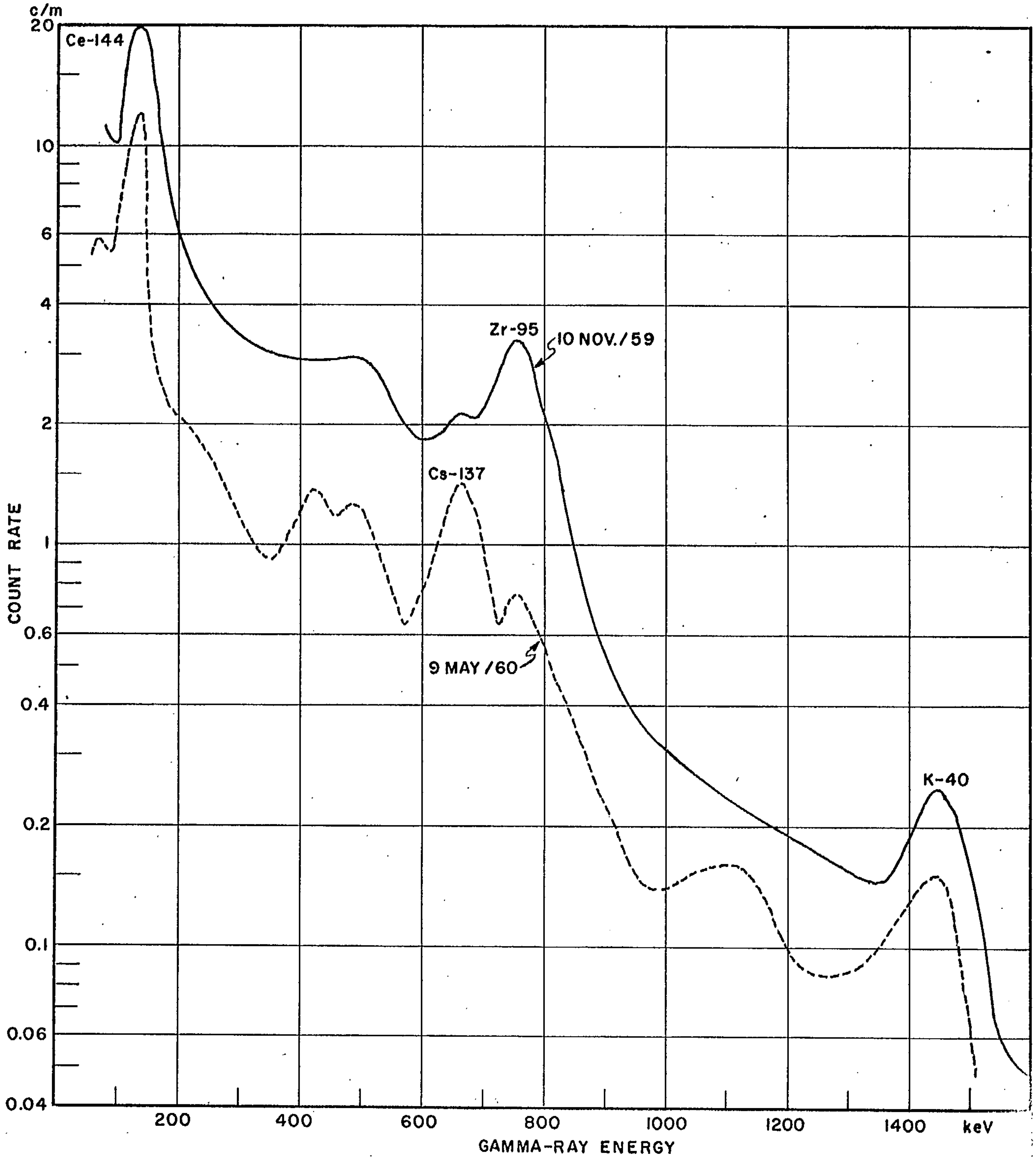

FIG.12- 6A-RED OSIER DOGWOOD LEAVES

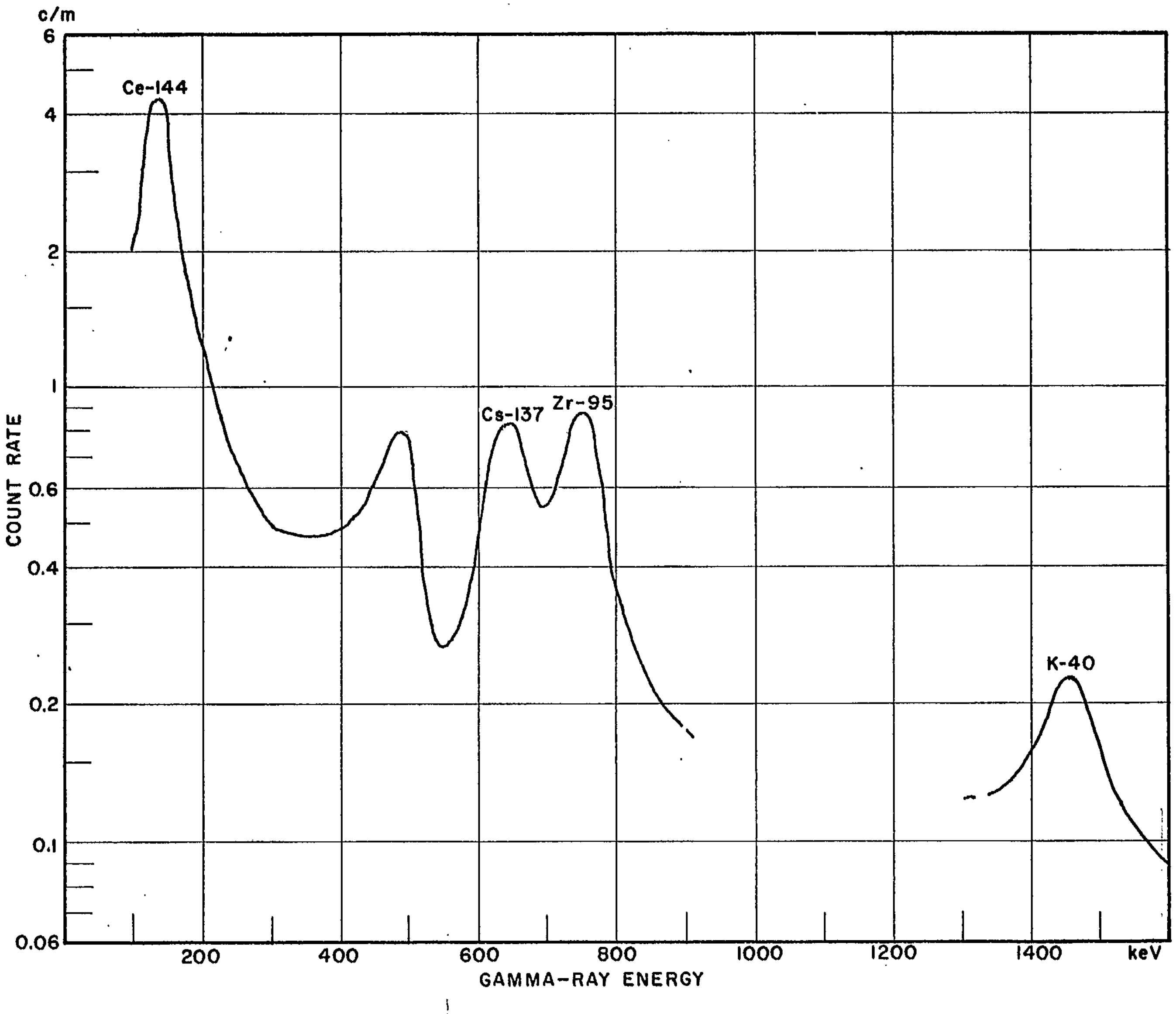

FIG. 13 - 7A-OREGON GRAPE LEAVES

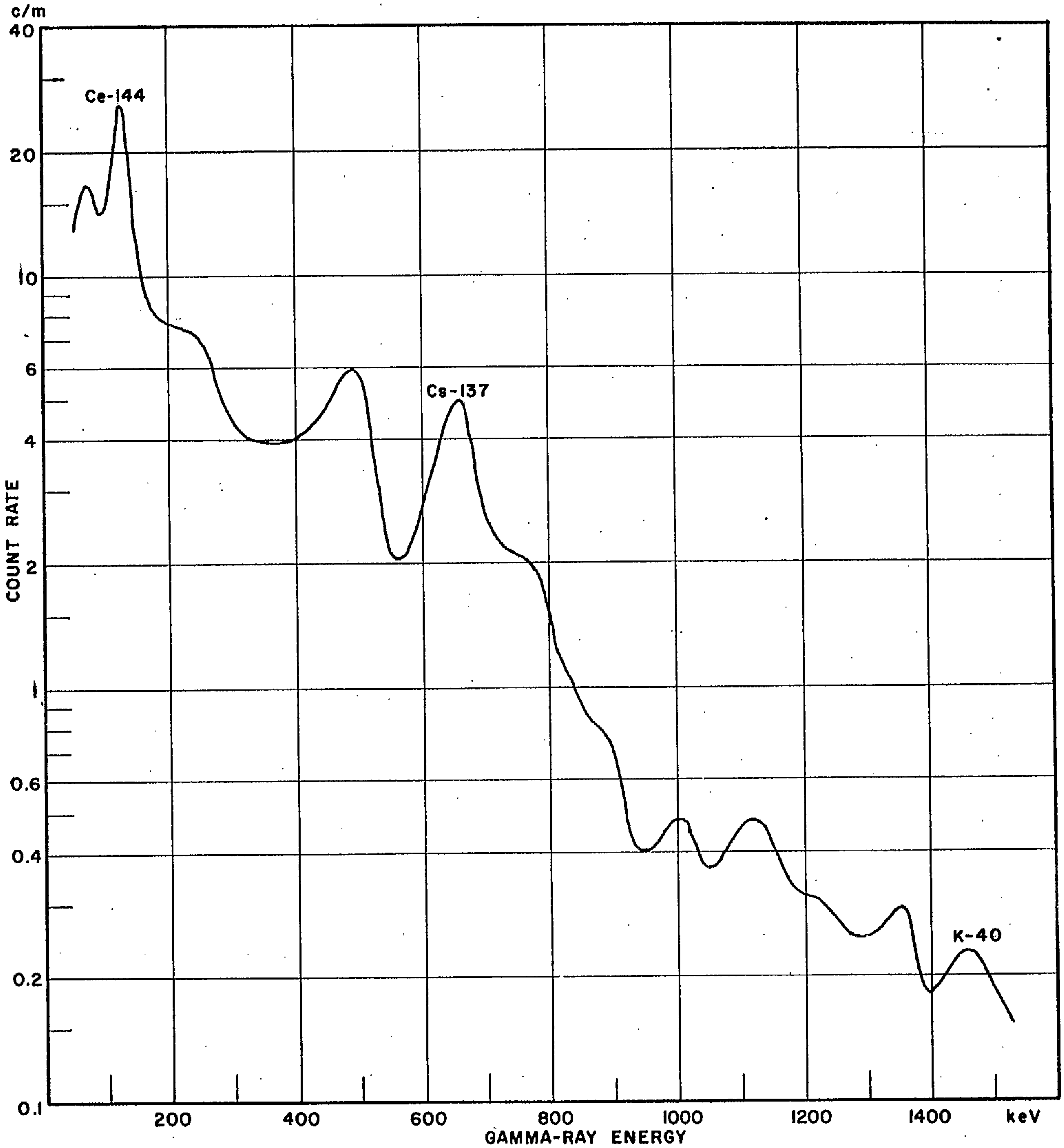

FIG. 14 - ASSORTED LEAVES (OBTAINED LOCALLY IN OTTAWA)