Assignment and Characteristic Radiations of the 14-day Tin Activity

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The tin isotope which decays with a 14-day half-life by an isomeric transition is definitely assigned to mass number 117. It was produced by the reactions $Cd^{114}(\alpha, n)$, $Sn^{116}(d, p)$, $Sn^{118}(n', 2n)$, and $Sn^{117}(n', n)$; and by the decay of indium 117 which is produced by the reaction $Cd^{116}(d, n)$. The cross section of the reaction $Sn^{117}(n', n)$ is about 1.8 times larger than the cross section of the reaction $Sn^{118}(n', 2n)$. Characteristic radiations are K and L conversion electrons of 0.146-Mev and 0.171-Mev energy, respectively, tin x-rays, and 0.175-Mev gamma-rays which are about 50 percent internally converted.

I. INTRODUCTION

IT has been reported[1] that a 13-day tin activity was produced by bombarding cadmium with alpha-particles. The characteristic radiation reported was negative particles only. No attempt was made for a mass assignment of this activity. Later it was reported[2] that a 14-day tin activity was produced by bombarding antimony with deuterons. Characteristic radiations reported were 0.13-Mev conversion electrons and 0.17-Mev gamma-rays. The energy of the electrons was measured with a spectrometer and the energy of the gamma-rays was measured by a lead absorption. The mass assignment was tentatively made to tin 119. The purpose of this paper is to report further investigations of this 14-day activity and to give it a definite assignment to tin 117. No previous assignment to tin 117 has been reported.

II. PROCEDURE

Samples of electromagnetically enriched cadmium and tin oxides** and tin metal, obtained by reducing the enriched tin oxide, were bombarded. Fast neutrons, 10-Mev deuterons, and 20-Mev alpha-particles were used as bombarding particles. In Table I are given the isotopic abundances supplied with each sample of enriched cadmium and in Table II are given the isotopic abundance supplied with each sample of enriched tin.

Samples were prepared for deuteron and alpha-particle bombardment by pressing the material into slots in chemically pure aluminum target blocks; while samples were prepared for fast neutron irradiation by placing a capsule containing the material in a small cadmium box placed behind a thick lithium target which was bombarded with 10-Mev deuterons. Measurement of the resulting activities in each case was accomplished with a thin window Geiger tube or with a freon-filled ionization chamber connected to a Wulf unifilar electrometer.

III. ALPHA-PARTICLE BOMBARDMENT OF ENRICHED CADMIUM

Comparison of results obtained by bombarding all eight samples of cadmium oxides, each enriched in a different isotope of cadmium, showed conclusively that the bombardment $Cd^{114}+\alpha$ produced the 14-day tin activity. The activity could then conceivably be attributed to either tin 116 or 117, though the former possibility would be contrary to Mattauch's rule. Figure 1 shows that the end point of the charged particle component of the radiation of the 14-day activity is 31 ± 1 mg/cm^2 of aluminum and that a tin x-ray and a gamma-ray of about 0.17-Mev energy constitute the electromagnetic component of this radiation.

Recently it was reported[3] that the ratio of the number of gamma-rays to the number of x-rays emitted by indium 111 in the 2.84-day activity was 1.72. The x-rays from this activity are indium x-rays and there are an almost equal number of 0.173-Mev and 0.247-

TABLE I. Isotopic abundance of enriched cadmium.

	Percent abundance of isotope of mass number		
	114	116	all others
Sample enriched in Cd^{114}	*94.2*	1.2	4.6
Sample enriched in Cd^{116}	18.4	*71.2*	10.4

TABLE II. Isotopic abundance of enriched tin.

	Percent abundance of isotope of mass number				
	116	117	118	120	all others
Sample enriched in Sn^{116}	*58.4*	8.9	10.3	10.8	11.6
Sample enriched in Sn^{117}	5.4	*75.3*	8.8	5.3	5.2
Sample enriched in Sn^{118}	1.1	2.0	*91.8*	2.2	2.9
Sample enriched in Sn^{120}	0.4	1.1	0.8	*95.4*	2.3

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[1] J. J. Livingood and G. T. Seaborg, Phys. Rev. **55**, 667 (1939).

[2] G. T. Seaborg and I. Perlman, Rev. Mod. Phys. **20**, 585 (1948).

** Supplied by the Y-12 plant, Carbide and Carbon Chemicals Corporation through the Isotope Division, AEC., Oak Ridge, Tennessee.

[3] Boehm, Huber, Marimer, Preswerk, and Steffun, Helv. Phys. Acta **22**, 69 (1949).

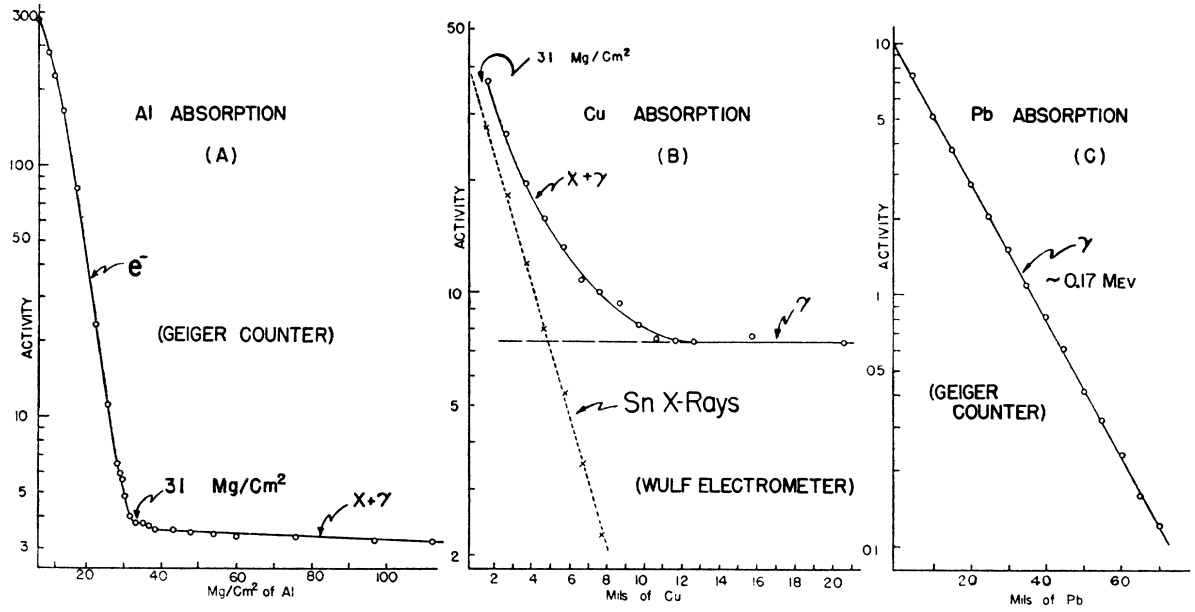

FIG. 1. (*A*) Aluminum absorption of the 14-day activity of tin 117 produced by the reaction $Cd^{114}(\alpha, n)$. The end point of the charged particle radiation is shown to be 31 ± 1 mg/cm² of aluminum. (*B*) Copper absorption of the same activity. The x-ray is shown to be tin x-ray. (*C*) Lead absorption of the same activity.-The gamma-radiation is shown to have an energy of about 0.17 Mev.

Mev gamma-rays. Since the x- and gamma-rays of the 14-day tin activity are comparable in energy to those of indium 111, a direct comparison of these activities can be made. This was done by means of a copper absorption of each activity with the Wulf electrometer. The 2.84-day activity of indium 111 was produced by bombarding cadmium 110 with deuterons. The results of this comparison indicated that the gamma-rays of the 14-day tin activity are about 50 percent internally converted.

IV. DEUTERON BOMBARDMENT OF ENRICHED CADMIUM

Two samples of cadmium oxide enriched respectively in isotopes 116 and 114 were bombarded with deuterons. Only the bombardment of cadmium 116 produced in the tin fraction the 14-day activity with an end point of 31 mg/cm² of aluminum. The parent of the 14-day tin activity could then conceivably be either indium 116 or indium 117, both of which are known to decay to tin. The former possibility would again be contrary to Mattauch's rule.

V. DEUTERON BOMBARDMENT OF ENRICHED TIN

Two samples of tin metal were bombarded with deuterons. One sample was enriched in isotope 116 and the other in isotope 118. Only the bombardment of tin 116 produced in the tin fraction this 14-day activity with an end point of 31 mg/cm² of aluminum. Therefore, the 14-day tin activity is very definitely assigned to tin 117. A copper and a thick aluminum absorption of the 14-day activity both revealed the presence of tin x-rays. A spectrogram, taken during the 14-day tin activity which was produced by this bombardment, showed that K and L conversion electrons have energies of 0.146 ± 0.006 Mev and 0.171 ± 0.006 Mev respectively, corresponding to a gamma-ray energy of 0.175 ± 0.006 Mev. The beta-ray spectrograph used was calibrated with the annhilation radiation of positrons from copper bombarded with deuterons, using lead foil as the radiator.

VI. FAST NEUTRON BOMBARDMENT OF ENRICHED TIN

A fast neutron bombardment of tin enriched in isotope 120 revealed no 14-day activity nor any activity with an end-point of 31 mg/cm² of aluminum. Samples of tin enriched, respectively, in isotopes 116, 117, and 118 were bombarded with fast neutrons. Each sample contained the 14-day tin 117 activity with an end-point of 31 mg/cm² of aluminum. Comparison of the specific activities of the 14-day tin 117 activity induced in these samples by the same neutron flux, indicated that tin 117 was produced by both the reactions $Sn^{118}(n^f, 2n)$ and $Sn^{117}(n^f, n)$ and that the latter has a cross section about 1.8 times as large as the former.

VII. ACKNOWLEDGMENTS

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