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NEUTRON DEFICIENT ISOTOPES OF TELLURIUM AND ANTIMONY

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While investigating the relative yields for the many reactions resulting from the irradiation of antimony with 200-Mev deuterons in the Berkeley 184-inch cyclotron several previously unreported isotopes of tellurium and antimony were encountered. The tellurium fraction when followed on a thin mica window counter could be resolved into half-life periods of 2.5 hrs, 6.0 days and a small amount of a long-lived component. The 2.5 hour period has not been further characterized with respect to mass number or mode of decay other than to note that the radiation is predominantly electrons. The 6.0-day period is accompanied by positrons which were shown to be due to a 3.5 minute antimony daughter which is undoubtedly the same activity assigned to Sb^{118} by Risser, Lark-Horowitz and Smith[1]. The positron energy was found to be 3.1 $\pm$ 0.2 Mev by absorption in beryllium and from the end point of the energy distribution curve taken with a low-resolution beta-ray spectrometer. Gamma activity is also present with this period. The 6.0-day tellurium showed a high abundance of x-rays, little or no conversion electrons and some gamma-ray activity which could be due to the 3.5 minute antimony daughter.

The tellurium fraction contained another component of 4.5-day half-life which could not be observed in the decay curve because of its low abundance but which was detected by means of its 39-hour antimony daughter. The 39-hour antimony showed x-rays of tin (critical absorption with cadmium, silver and palladium), no detectable hard radiation or electrons and is apparently identical with an activity recently assigned to Sb^{119} by Coleman and Pool[2].

In order to produce a more favorable ratio of the 4.5-day tellurium to 6.0-day tellurium, antimony was bombarded with 40-Mev deuterons which from other measurements was predicted to produce the d,4n reaction in good yield and the d,5n reaction in poorer yield. If the 4.5-day tellurium is Te^{119} and the 6.0-day period is Te^{118} the desired result should be achieved. The counting rates for the x-rays of the two activities were found to be in the ratio of 40:1 in the direction anticipated. Since the activity of several days half-life is largely that of the 4.5-day tellurium (except for the positrons of the 3.5-minute Sb^{118}), the negative particles and electromagnetic radiation may be assumed to belong to this isotope. Conversion electrons of 0.2 Mev and 0.5 Mev were measured with the low resolution beta-ray spectrometer and a hard gamma-ray of about 1.5 Mev was detected through a lead absorption curve. Softer gamma radiation could have been present. All tellurium decay curves tailed out into a longer period, probably Te^{121}.

The antimony fraction from bombardments of antimony with 200-Mev deuterons showed a number of periods which could be resolved by selectively counting the x-rays through beryllium and the electrons without absorber. There was x-ray activity of a few hours half-life which could be a mixture of the 2.8 hour and 5.1 hour periods reported by Coleman and Pool. The 2.8-day Sb^{122} showed up well in the curve taken without absorbers and the 39-hour antimony was prominent in the decay curve taken through beryllium. The yield of the 39-hour antimony was much greater than that which could have grown from its 4.5-day tellurium parent, indicating direct formation. Another antimony isotope of 6.0-day half-life was also observed. This activity is characterized by a preponderance of x-ray and gamma-ray activity with electrons in low abundance. Since the 6.0-day antimony did not appear in antimony removed from tellurium, the tellurium isobar is either stable or of half-life less than 10 minutes. Although the half-life is the same as that of the tellurium mentioned above, it could be separated chemically with antimony from tellurium and there was no positron activity accompanying it. It is not possible to make an isotopic assignment of this activity. After the decay of the 6.0-day antimony, the curve turned into the 60-day period of Sb^{124} which was identified also by its radiation characteristics. The formation of Sb^{124} presents the unanswered question as to whether this isotope is formed by the high energy deuterons or by secondary low energy neutrons.

Table I lists the isotopes of antimony and tellurium found in the bombardment of antimony with 200-Mev deuterons. The cross sections for their formation will be given in a later publication in which the yields for the large number of products of 200-Mev deuterons on antimony will be discussed.

The assignment of the 4.5-day tellurium - 39-hour antimony isobars to mass number 119 is most reasonable in view of their production with 40-Mev deuterons on antimony, their decay characteristics and the possibilities open. This assignment agrees with that of the 39-hour antimony by Coleman and Pool from other evidence. The most reasonable assignment of the 6.0-day tellurium - 3.5 minute antimony isobars is mass number 118. They were produced with 40-Mev deuterons on antimony which would be impossible for mass number 116 and probably for mass number 117. An odd mass number (117) is also unlikely in view of observed half-life relationships. This isotopic assignment is in apparent conflict with the assignment of the 5.1-hour antimony to mass number 118[2]. However, it is possible that the 3.5-minute antimony and the 5.1-hour antimony are isomeric and that in the decay of the 6.0-day tellurium parent only the upper state (3.5-minute antimony) is formed.

The 6.0-day antimony has not yet been sufficiently characterized to permit a guess of the isotopic assignment but in view of the assignments already made it is not unlikely that this isotope is isomeric with another known antimony activity.

The cooperation of Dr. D. C. Sewell, Mr. J. T. Vale, and all of those whose operation of the 184-inch cyclotron made these irradiations possible is gratefully acknowledged.

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Table I

Isotopes of Sb and Te formed in the
Irradiation of Antimony with 200-Mev Deuterons

Isotope	Half-life	Decay mech.	Energy (Mev) Particles	Energy (Mev) γ-Rays	Other References
Sb	Several hours	K, e^-			(2)
Sb^{118}	3.5minutes	β^+, γ	3.1 ± 0.2		(1)
Sb^{119}	39 hours	K	none		(2)
Sb	6.0 days	K, e^-, γ or IT, e^-, γ		1.1	
$*Sb^{122}$	2.8 days	β^-, γ, e^-			(3)
$*Sb^{124}$	60 days	β^-, γ			(3)
Te^{118}	6.0 days	K, no γ(?)			
Te^{119}	4.5 days	K, e^-, γ	0.2,0.5	1.4	
$*Te^{121}$	140 days	IT, e^-, γ			(4)

*Isotope identified from properties listed in the literature but not further characterized.

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(1) Risser, Lark-Horowitz and Smith, Phys. Rev. 57, 355(1940).
(2) Coleman and Pool, Phys. Rev. 72, 1070(1947).
(3) Livingood and Seaborg, Phys. Rev. 55, 414(1939).
(4) Pool and Edwards, Phys. Rev. 69, 140(1946).