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CARRIER-FREE RADIOISOTOPES FROM CYCLOTRON TARGETS
XIII. PREPARATION AND ISOLATION OF $\text{Sc}^{44,46,47,48}$ FROM TITANIUM

Jeanne D. Gile, Warren M. Garrison and Joseph G. Hamilton

September 20, 1950

Berkeley, California

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CARRIER-FREE RADIOISOTOPES FROM CYCLOTRON TARGETS
 XIII. PREPARATION AND ISOLATION OF $\text{Sc}^{44,46,47,48}$ FROM TITANIUM*

Jeanne D. Gile, Warren M. Garrison and Joseph G. Hamilton.

September 20, 1950

Crocker Laboratory, Radiation Laboratory, and Divisions of Medical Physics, Experimental Medicine, and Radiology; University of California, Berkeley and San Francisco, California.

The radioactive ¹scandium was prepared by bombardment of natural titanium with 20 Mev deuterons in the 60-inch cyclotron at Crocker Laboratory. At this energy, radio-scandium is produced by the nuclear reactions: $\text{Ti}^{46}(\text{d},\alpha)\text{Sc}^{44}$, $\text{Ti}^{46}(\text{d},2\text{p})\text{Sc}^{46}$, $\text{Ti}^{47}(\text{d},2\text{p})\text{Sc}^{47}$, $\text{Ti}^{47}(\text{d},\alpha\text{n})\text{Sc}^{44}$, $\text{Ti}^{48}(\text{d},\alpha)\text{Sc}^{46}$, $\text{Ti}^{48}(\text{d},2\text{p})\text{Sc}^{48}$, $\text{Ti}^{49}(\text{d},\alpha)\text{Sc}^{47}$, $\text{Ti}^{49}(\text{d},\alpha\text{n})\text{Sc}^{46}$, $\text{Ti}^{50}(\text{d},\alpha\text{n})\text{Sc}^{47}$, $\text{Ti}^{50}(\text{d},\alpha)\text{Sc}^{48}$; long-lived radio-calcium and radio-vanadium are produced concurrently by the reactions: $\text{Ti}^{48}(\text{d},\alpha\text{p})\text{Ca}^{45}$, $\text{Ti}^{48}(\text{d},2\text{n})\text{V}^{48}$, $\text{Ti}^{48}(\text{d},\text{n})\text{V}^{49}$, $\text{Ti}^{47}(\text{d},\text{n})\text{V}^{48}$, $\text{Ti}^{49}(\text{d},2\text{n})\text{V}^{49}$. In the procedure described here, the carrier-free radio-scandium is separated as a radio-colloid ² from an ammonium hydroxide - hydrogen peroxide solution containing the target element and the concurrently produced radioisotopes of calcium and vanadium.

The titanium target (C.P. metal ³ powder supported on a copper target plate with 0.25 mil platinum foil) was bombarded for 100 μa hr. at an average beam intensity of 20 μa . After aging for 24 hours, the bombarded titanium metal powder (approximately 1 gm) was dissolved in 40 ml of 18 N sulfuric acid containing 5 percent 16 N nitric acid. A small amount of undissolved inactive material was removed by centrifugation. The supernatant was slowly added to 200 ml of 8 N

*This document is based on work performed under Contract No. W-7405-eng-48-A for the Atomic Energy Commission.

¹ G. T. Seaborg and I. Perlman, Rev. Mod. Phys. 20, 585 (1948)

² O. Hahn, Applied Radiochemistry, Cornell University Press Ithaca, New York, 1936.

³ Scandium could not be detected by spectrographic analyses.

ammonium hydroxide containing 15 ml of 30 percent hydrogen peroxide to give a clear yellow "solution" of the following composition: (1) titanium as the soluble pertitanate, (2) radio-calcium, (3) radio-vanadium as pervanadate, (4) radio-scandium as radio-colloidal aggregates^{2,4}. This "solution" was then passed through two consecutive Whatman No. 42 filter papers which retained over 95 percent of the scandium activity as adsorbed radio-colloid. After washing with 10 ml of water, the scandium activity was quantitatively removed in 10 ml of 1 N hydrochloric acid which after neutralization with the ammonium hydroxide - hydrogen peroxide solution was again passed through filter paper. Three such cycles gave a hydrochloric acid solution of carrier-free radio-scandium containing less than 2 gamma of titanium. In a chemical separation performed on this final fraction using added scandium, calcium, titanium and vanadium carriers, over 98 percent of the activity was recovered in the scandium fraction.

The decay was followed for 45 days and showed initially a composite 2.5-day half-life corresponding to the shorter-lived scandium isotopes (2.2-day Sc^{44} , 3.4-day Sc^{47} , 44-hour Sc^{48}). Twenty-four hours after bombardment, absorption measurements in aluminum showed the 1.4 Mev beta particle of 3.9-hr. Sc^{44} which is produced⁵ by isomeric transition from 2.2-day Sc^{44} . The gamma radiation had a half-thickness of 11.0 gm in lead. Thirty-six days after bombardment, the activity had an approximately 80-day half-period; aluminum absorption measurements showed the 0.36 and 1.5 Mev beta particles previously reported⁶ for 85-day Sc^{46} .

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⁴ M. H. Kurbatov and J. D. Kurbatov, J. Chem. Phys. 13, 208 (1945).

⁵ H. Walke, Phys. Rev. 57, 163 (1940)

⁶ H. Walke, E. J. Williams and G. R. Evans, Proc. Roy. Soc. (London) A171, 360, (1939).