

UNIVERSITY OF CALIFORNIA

Radiation Laboratory

Contract No. W-7405-eng-48

UNCLASSIFIED

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

DISCLAIMER

This document was prepared as an account of work sponsored by the United States Government. While this document is believed to contain correct information, neither the United States Government nor any agency thereof, nor the Regents of the University of California, nor any of their employees, makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by its trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or the Regents of the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof or the Regents of the University of California.

INSTALLATION:

No. of Copies

Argonne National Laboratory	8
Armed Forces Special Weapons Project	1
Atomic Energy Commission, Washington	2
Battelle Memorial Institute	1
Brush Beryllium Company	1
Brookhaven National Laboratory	4
Bureau of Medicine and Surgery	1
Bureau of Ships	1
Carbide and Carbon Chemicals Division (K-25 Plant)	4
Carbide and Carbon Chemicals Division (Y-12 Plant)	4
Chicago Operations Office	1
Columbia University (J. R. Dunning)	1
Columbia University (G. Failla)	1
Dow Chemical Company	1
H. K. Ferguson Company	1
General Electric, Richland	3
Harshaw Chemical Corporation	1
Idaho Operations Office	1
Iowa State College	2
Kansas City Operations Branch	1
Kellex Corporation	2
Knolls Atomic Power Laboratory	4
Los Alamos Scientific Laboratory	3
Mallinckrodt Chemical Works	1
Massachusetts Institute of Technology (A. Gaudin)	1
Massachusetts Institute of Technology (A. R. Kaufmann)	1
Mound Laboratory	3
National Advisory Committee for Aeronautics	1
National Bureau of Standards	3
Naval Radiological Defense Laboratory	2
New Brunswick Laboratory	1
New York Operations Office	3
North American Aviation, Inc.	1
Oak Ridge National Laboratory	8
Patent Branch, Washington	1
Rand Corporation	1
Sandia Corporation	1
Santa Fe Operations Office	2
Sylvania Electric Products, Inc.	1
Technical Information Division (Oak Ridge)	15
USAF, Air Surgeon (Lt. Col. R. H. Blount)	1
USAF, Director of Armament (Captain C. I. Browne)	1
USAF, Director of Research and Development (Col. R. J. Mason, Fred W. Bruner)	2
USAF, Eglin Air Force Base (Major A. C. Field)	1
USAF, Kirtland Air Force Base (Col. Marcus F. Cooper)	1
USAF, Maxwell Air Force Base (Col. F. N. Moyers)	1
USAF, NEPA Office	2
USAF, Office of Atomic Energy (Col. H. C. Donnelly, A. A. Fickel)	2
USAF, Offutt Air Force Base (Col. H. R. Sullivan, Jr.)	1
USAF, Wright-Patterson Air Force Base (Rodney Nudenberg)	1

-2a-

<u>INSTALLATION:</u>	<u>No. of Copies</u>
U. S. Army, Atomic Energy Branch (Lt. Col. A. W. Betts)	1
U. S. Army, Army Field Forces (Captain James Kerr)	1
U. S. Army, Commanding General, Chemical Corps Technical Command (Col. John A. MacLaughlin thru Mrs. Georgia S. Benjamin)	1
U. S. Army, Chief of Ordnance (Lt. Col. A. R. Del Campo)	1
U. S. Army, Commanding Officer, Watertown Arsenal (Col. C. H. Deitrick)	1
U. S. Army, Director of Operations Research (Dr. Ellis Johnson)	1
U. S. Army, Office of Engineers (Allen O'Leary)	1
U. S. Army, Office of the Chief Signal Officer (Curtis T. Clayton thru Maj. George C. Hunt)	1
U. S. Army, Office of the Surgeon General (Col. W. S. Stone)	1
U. S. Geological Survey (T. B. Nolan)	2
USAF, Director of Plans and Operations (Col. R. L. Applegate)	1
U. S. Public Health Service	1
University of California at Los Angeles	1
University of California Radiation Laboratory	5
University of Rochester	2
University of Washington	1
Western Reserve University	2
Westinghouse Electric Company	4
Naval Medical Research Institute	1
California Institute of Technology (R. F. Bacher)	1
TOTAL	138

Information Division
Radiation Laboratory
University of California
Berkeley, California

CARRIER-FREE RADIOISOTOPES FROM CYCLOTRON TARGETS
 XIII. PREPARATION AND ISOLATION OF 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: Ti⁴⁶(d,α)Sc⁴⁴, Ti⁴⁶(d,2p)Sc⁴⁶, Ti⁴⁷(d,2p)Sc⁴⁷, Ti⁴⁷(d,αn)Sc⁴⁴, Ti⁴⁸(d,α)Sc⁴⁶, Ti⁴⁸(d,2p)Sc⁴⁸, Ti⁴⁹(d,α)Sc⁴⁷, Ti⁴⁹(d,αn)Sc⁴⁶, Ti⁵⁰(d,αn)Sc⁴⁷, Ti⁵⁰(d,α)Sc⁴⁸; long-lived radio-calcium and radio-vanadium are produced concurrently by the reactions: Ti⁴⁸(d,αp)Ca⁴⁵, Ti⁴⁸(d,2n)V⁴⁸, Ti⁴⁸(d,n)V⁴⁹, Ti⁴⁷(d,n)V⁴⁸, Ti⁴⁹(d,2n)V⁴⁹. 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 Sc⁴⁴, 3.4-day Sc⁴⁷, 44-hour Sc⁴⁸). Twenty-four hours after bombardment, absorption measurements in aluminum showed the 1.4 Mev beta particle of 3.9-hr. Sc⁴⁴ which is produced⁵ by isomeric transition from 2.2-day Sc⁴⁴. 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 Sc⁴⁶.

We are grateful to Professor G. T. Seaborg for helpful suggestions and Mr. T. Putnam, Mr. G. B. Rossi and the crew of the 60-inch cyclotron for the bombardments.

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).