The absorption peaks of the ICl^{35} and ICl^{37} molecules were found at 6980 and 6684 megacycles, respectively, with a possible error of one part in 10^3. The following values for the rotational constants, B_e, moments of inertia, I, and interatomic distances, r_e, have been calculated:

	B_e	I	r_e
ICl^{35}	0.1167 cm^{-1}	2.397×10^{-38} g/cm^2	2.303A
ICl^{37}	0.1118 cm^{-1}	2.502×10^{-38} g/cm^2	2.303A

The value of B_e for ICl^{35} obtained here is in disagreement with that of Curtis and Patkowski,[3] 0.1141 cm^{-1}, obtained from an analysis of the vibration-rotation bands of ICl^{35}.

The absorption peak of 10^{-6} cm^{-1} for ICl^{35} is in agreement with that given by the theory of Van Vleck and Weisskopf[4] for a choice of the line-breadth parameter, $\Delta\nu/c$, at atmospheric pressure of 0.08 cm^{-1} and assuming a linear $\Delta\nu/c$-pressure relationship. The measured half-breadths, linear in pressure over the 2 to 20-mm Hg pressure range investigated, were in harmony with this choice. A preliminary analysis of the line profiles shows the absorption in the wings of the lines to be in excess, by a factor 5 roughly, of that predicted by the Van Vleck-Weisskopf theory.

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The Crystal Structure of Element 43

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THE chemistry of element 43 was first studied by Perrier and Segrè,[1] from samples containing tracer quantities of technetium (Tc) produced by deuteron bombardment of molybdenum. More recently, a long-lived isotope has been found to be one of the products from U^{235} fission.[2] Lately, this long-lived, *beta*-active isotope has been produced by neutron bombardment of Mo.[3]

The material used in this work was a technetium preparation separated from fission products by G. W. Parker, J. W. Ruch, and J. Reed of the Clinton Laboratory. From this original sample, a number of chemical preparations in microgram amounts have been made by Dr. Sherman Fried of the Argonne Laboratory. Two of these proved to be the element itself. The fact that the sample was metallic technetium was shown conclusively by the characteristics of the x-ray pattern itself.

Technetium crystallizes in the hexagonal close-packed arrangement; that is to say, it is isomorphous with rhenium, ruthenium, and osmium. The cell, which contains two atoms of Tc, has the following dimensions:

$$a=2.735\pm0.001\text{A},\quad c=4.391\pm0.001\text{A},\quad c/a=1.604.$$

The calculated density, based on the atomic weight of 99, is 11.487 g/cm^3. Each Tc atom has twelve nearest neighbors. Six are at a distance of 2.735A—the cell translation—and six at a somewhat smaller distance, 2.704A.

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Mass Spectrometric Study of Fission Element 43

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A SAMPLE of element 43 (Tc) separated from uranium fission products by Messrs. G. W. Parker, J. W. Ruch, and J. Reed of the Clinton Laboratories of the Monsanto Chemical Company was analyzed by a mass spectrometer in order to determine which of the possible fission isotopes have long lives. The existence of a Tc^{99} isotope with a half-life greater than forty years was first predicted by Seaborg and Segrè.[1] Glendenin, from experiments with fission products, set the half-life of a long-lived fission isotope of technetium at more than 3000 years.[2] A long-lived technetium activity was found in fission products by Lincoln and Sullivan,[2] and Schuman.[2] Motta, Boyd, and Larson obtained a half-life of 9.4×10^5 years with a sample prepared by neutron bombardment of molybdenum.[3]

The sample of fission technetium used for our work was distilled into the ionization chamber of a Nier-type spectrometer as NH_4TcO_4. The resolved ion currents were recorded by means of a vibrating reed electrometer and a Leeds and Northrup Speedomax recorder. The curves obtained in the Tc^+ ion position are shown in Fig. 1. Curve *a* is the plot of the 98–103 mass range before the technetium was distilled into the source. The six large peaks in the spectrum are due to doubly charged mercury ions which were used as mass standards. Curve *b* is a plot of the same

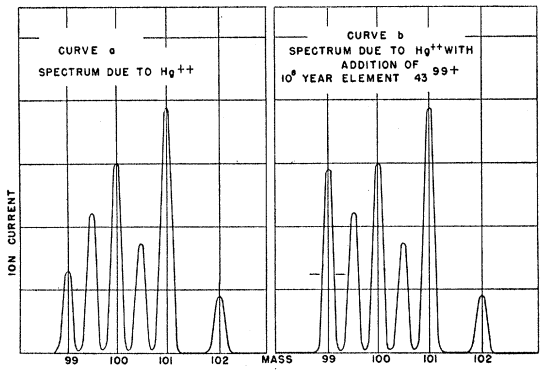

FIG. 1. Mass spectra showing increased intensity at mass 99 when technetium is added.

region obtained while the technetium was distilling into the source. The marked increase at mass 99 is immediately apparent. In addition to the increased peak at mass 99 shown in Fig. 1, new single peaks appeared at masses 115, 131, and 147, due to $Tc^{99}O^+$, $Tc^{99}O_2^+$, and $Tc^{99}O_3^+$, respectively. These results show that the technetium formed in fission contains a long-lived isotope at mass 99, and that all other possible long-lived fission isotopes of technetium are present to less than 3 percent of this value. Making use of the fission yield curve, we may conclude that at least 97 percent of the Tc^{101} nuclei formed in fission decay with a half-life shorter than six months. Assuming a packing fraction of -6×10^{-4}, and a conversion factor of 1.000275, the atomic weight of long-lived fission technetium is found to be 98.913.

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Production and Properties of a Long-Lived Radio-Isotope of Element 43*

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THE possible existence of a long-lived beta-active, or stable isotope of element 43 (Tc) was suggested in the early work of Seaborg and Segrè[1] wherein a 6×10^4-fold decay of an isomeric 6.6-h Tc^{99} was observed without giving rise to a detectable radiation from the ground state. Recently, the presence of a long-lived isotope of Tc among the fission products from U-235 has been established.[2]

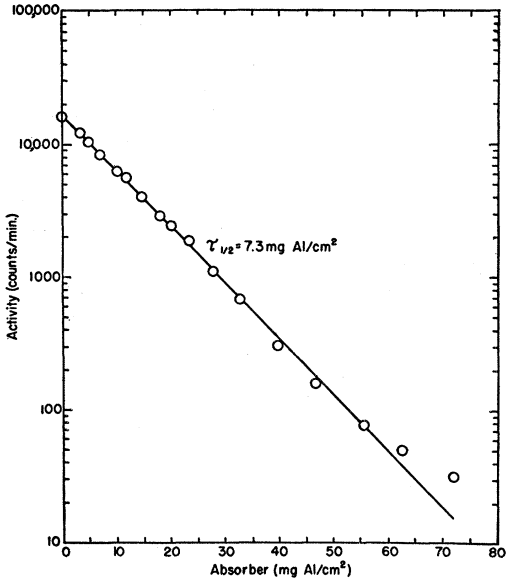

FIG. 1. Aluminum-absorption curve for the beta-radiations of Tc^{99}.

Since the 67-h Mo^{99} parent of Tc^{99} may be formed in appreciable yield by neutron irradiation of stable Mo^{98}, it was decided to attempt to produce the ground state activity by irradiating quantities of pure Mo metal with neutrons from the Clinton pile.

Four forty-gram molybdenum metal samples were irradiated in Stringer 21 for approximately one month each from February to May 1946. After chemical separation from the metal matrix in which it was produced, the Tc activity was purified, coprecipitated with PtS_2 carrier, mounted, and counted. A typical aluminum-absorption curve obtained with the sample placed at 30 percent geometry with respect to a thin mica end-window G-M counting tube is shown in Fig. 1. An average half-thickness of 7.3 mg Al/cm² corresponding to a range of 85 mg Al/cm², and to a maximum beta-energy[3] of 0.32 Mev was observed. A beta:gamma counting ratio in excess of 2000 has been found, and this has been taken to indicate the absence of gamma-radiation more energetic than 0.1 Mev. The foregoing radiation characteristics are virtually identical with those observed for the long-lived Tc isotope produced in fission.

A subsequent neutron irradiation of four kilograms of Mo for 112 days permitted the separation of weighable quantities of element 43 (September 1946). Measurements of the specific activity were conducted as follows: After extensive chemical purification to remove an initial Re and Mo contamination, *ca.* 100-microgram amounts of Tc metal were electroplated on polished copper disks, which then were weighed on a semimicro balance and counted. Uncertainties as to counting efficiency, scattering, etc., were minimized by electroplating a standardized Co^{60} preparation which was counted under identical conditions. The best average value for the half-life of the Tc activity obtained thus far has been 9.4×10^5 years.

The yield of long-lived activity resulting from the neutron irradiation of molybdenum metal is consistent with its production by the reaction, $Mo^{98}(n,\gamma)Mo^{99}$, followed by the radioactive decay of the 67-h Mo^{99} so formed. If the 9.4×10^5-y Tc had been produced by neutron capture in the less abundant stable Mo^{100} isotope followed by the decay of 14-m Mo^{101}, the yield of activity would have been roughly one-third that actually found. Accordingly, a mass of 99 is proposed for this radioactive isotope of element 43.

A few qualitative observations on the macro-chemistry may be of interest. A highly insoluble, dark-brown sulfide, presumably Tc_2S_7, precipitates readily from $4MH_2SO_4$ solutions. The heptavalent oxidation state may give rise to a light pink coloration when present in concentrations above 10^{-3}M. Many of the chemical properties observed at extremely low (i.e., tracer) concentrations by Perrier and Segrè[4], using 88-d Tc^{97}, have been confirmed. Detailed observations on the chemistry of element 43 will be reported elsewhere.

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