The Half-Life of Actinouranium

Forrest Western and Arthur E. Ruark, *Missouri Valley College and University of Pittsburgh*

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Values of the half-life of actinouranium are obtained from data on a Morogoro pitchblende and a uraninite from Great Bear Lake, analyzed by von Grosse and Marble, respectively. Computations were made with two extreme values, 0.03 and 0.04, for the actinium "branching ratio" B. Half-life values in 10^8 years are:

B	0.03	0.04
Morogoro	3.23	4.54
Great Bear Lake	4.65	6.21
Mean from 4 minerals	3.38	4.45

In earlier papers it was shown[1] that it is very probable there is only one actinouranium isotope. On this basis we derived a set of equations which made it possible, using data on radioactive minerals, to determine the decay constants of U I and AcU, as well as the ages of the minerals. Recently, Aston[2] has verified his earlier results on the isotopic constitution of lead from Katanga pitchblende, Norwegian thorite, and Wilberforce uraninite, which were discussed in our papers. He gives data for two additional minerals, a Morogoro pitchblende and a Great Bear Lake uraninite.

Table I gives relevant data. The chemical analyses are due to von Grosse[3] and J. P. Marble,[4] respectively.

Both these minerals are suitable for computation of the half-life of AcU. The Morogoro material contains only a trace of thorium, so that all the lead may be considered radiogenic, while the absence of thorium in the Katanga material makes it possible to correct for the presence of ordinary lead, by using Aston's figures for the relative abundance of isotopes in the latter. In the absence of direct atomic weight determinations, we may compute the atomic weight of the lead in each of these minerals from its isotopic constitution. When we apply Eqs. (16), (17) and (18) of our earlier paper[5] on the half-life of AcU to a thorium-free mineral, using an atomic weight computed from the percentages of the lead isotopes, the results are practically independent of the exact values adopted for the weights of these isotopes and of uranium, which are still in doubt by several hundredths of a unit. In the case of Great Bear Lake, the rare isotopes 203, 204, 205, 209, 210, present in common lead, were taken into account, at least approximately, although correction for them changes the final results by a negligible amount. Just as before, we have carried out the computations for two values of B, the actinium "branching ratio," namely 3 and 4 percent. Table II shows results for all the

TABLE I. *Morogoro Pitchblende and Great Bear Lake Uraninite.*

	Morogoro	Great Bear Lake
Percentage U:	70.45	52.06
Percentage Th:	About 0.2	0.0
Percentage Pb:	8.30	10.48
Pb/U:	0.1178	0.2013
(Radiogenic Pb)/U:	0.1178	0.1919
Isotopic constitution of Pb, percent:		
Pb^{206}	93.1	89.8
Pb^{207}	6.9	7.9
Pb^{208}	0.0	2.3

[1] Western and Ruark, J. Chem. Phys. **1**, 717 (1933); Phys. Rev. **44**, 675 (1933); Phys. Rev. **45**, 69 (1934). A slight correction to the second paper should be noted. The numbers given for the half-life of AcU in the abstract are means of half lives obtained from two minerals. They may be replaced by the half-lives corresponding to the mean decay constants.

[2] Aston, Proc. Roy. Soc. **A140**, 535 (1933).

[3] A. von Grosse, Phys. Rev. **42**, 565 (1932).

[4] Quoted by F. L. Hess. Other samples are discussed in Report of the National Research Council Committee on Geologic Time, 1932, page 3.

[5] Western and Ruark, Phys. Rev. **44**, 675 (1933).

TABLE II. *Decay constants of* $AcU \times 10^9$, *in* $yr.^{-1}$.

Material	$B=0.03$	$B=0.04$
Morogoro pitchblende:	2.15	1.53
Great Bear uraninite:	1.49	1.12
Norwegian bröggerite:	2.62	2.07
Wilberforce uraninite:	1.94	1.51
Means	2.05	1.56
AcU half-life, yr.	3.38×10^8	4.45×10^8

minerals we have studied. The spread of the individual values is unsatisfactory, but it appears probable that study of further minerals will not change the mean decay constants for given values of B by more than 25 percent. The outstanding difficulty is the uncertainty of B.

The half-life of U I (insensitive to change of B) is found to be $4.58_4 \times 10^9$ yr. from Morogoro, and $4.57_7 \times 10^9$ yr. from Great Bear Lake, in agreement with the value given in our earlier paper.

Using the mean decay constants of Table II, we can write a simple equation for the age t, applicable to any thorium-free mineral for which we can deduce the amount of Ra G. For such minerals, t is insensitive to changes in B, hence we may use a mean value, $B=0.035$. Then Eq. (17) of our earlier paper[5] becomes:

$$t = 15{,}220 \log_{10} (1 + 1.158 \text{ Ra G/U}) \text{ million years.}$$

It must be noted that Ra G refers only to that part of the 206 lead which is of radioactive origin. This equation yields ages of 790 and 1240 million years for the Morogoro and Great Bear Lake materials, respectively.

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Note added in proof: Francis and Da-Tchang[6] find 0.04 for the actinium branching ratio, by the older method which involves precipitation of actinium with tantalum. Marble[7] gives 206.054 for the atomic weight of the Great Bear Lake material.

[6] Francis and Da-Tchang, Comptes Rendus **198**, 733 (1934).

[7] Marble, J.A.C.S. **56**, 854 (1934).