exerted a selective action upon uranium isotopes, which resulted in the concentration of the isotope of mass 238. Examination of the uranium contained in the kolm might throw some light upon this question. This we propose to do.

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[CONTRIBUTION FROM THE T. JEFFERSON COOLIDGE, JR. MEMORIAL LABORATORY OF HARVARD UNIVERSITY]

THE ATOMIC WEIGHT OF URANINITE LEAD FROM WILBERFORCE, ONTARIO, CANADA

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As a check on the age determination of a specimen of uraninite occurring in Cardiff township near Wilberforce, Ontario, Canada, by means of the uranium–thorium–lead ratio the atomic weight of the lead has been determined.[1]

A selected crystal of 700 g. was broken up with a clean hammer and anvil and the fragments crushed in a carefully cleaned jaw crusher. The product was then coarsely ground in a Quaker grinding mill. This mill had been previously cleaned by passing through it a considerable quantity of marble. The marble powder was found to be free from detectable quantity of lead.

About 300 g. of the powdered uraninite was boiled with concentrated nitric acid, and the residue, which later was found to consist largely of fluorspar, was separated and washed by decantation. From the solution the lead was precipitated by adding an excess of sulfuric acid and the precipitate was washed by decantation. The lead sulfate was metathesized to the carbonate by repeated treatment with hot sodium carbonate solution, and after the lead carbonate had been washed by decantation it was dissolved in nitric acid and freed from a small amount of insoluble material.

The original insoluble residue was further boiled first with nitric acid, and again after the addition of sulfuric acid, and the whole was evaporated to the fuming point of sulfuric acid. After being washed with water the residue was extracted with hot ammonium acetate solution, and the lead was precipitated as chromate. This in turn was washed and converted to sulfate by treatment with nitric and sulfuric acids. Conversion to nitrate was accomplished as in the case of the main portion and the two portions were then combined.

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[1] For a description of geologic occurrence and analyses, by Ellsworth, Todd, Spence and Carnochan, see Exhibit A, appended to the mimeographed report of the Committee on the Measurement of Geological Time by Atomic Disintegration to the division of Geology and Geography of the National Research Council, May 3, 1900. Also *Trans. Can. Inst. Min. and Met.*, 2 (1930); *Amer. Mineralogist*, (Oct., 1930).

Since the glass dishes employed were obviously etched, owing to liberation of hydrofluoric acid from the fluorspar, in order to discover whether lead had been introduced from the dishes, they were separately heated with hydrofluoric acid solution, and the extract after evaporation was tested for lead. Since the total quantity of lead chromate recovered by treatment of three watch glasses, a beaker, flask and two porcelain evaporating dishes was only 0.0022 g., no serious contamination with common lead could have occurred during the treatment of the uraninite with acid.

The combined lead nitrate solution was evaporated to dryness to expel the excess of acid and then was recrystallized four times by solution in water and precipitation with a large quantity of concentrated nitric acid. The earlier experience of Baxter and Grover[2] showed that this treatment is adequate for removal of foreign metals. Solution of the nitrate in water was then followed by filtration through a platinum sponge crucible into a quartz dish. A considerable excess of hydrochloric acid was next added and the precipitated lead chloride was washed by decantation. Finally the chloride was recrystallized from water, once in quartz and three times in platinum.

To remove traces of silica the chloride was dried and sublimed in a current of dry hydrogen chloride in a quartz tube. It was prepared for weighing by fusion in a weighed quartz boat in a Richards bottling apparatus. Weighing of the chloride was followed by solution and precipitation with a weighed equivalent amount of the purest silver,[3] and the end-point of the precipitation was found with the assistance of the nephelometer by the addition of small amounts of dilute silver and chloride solutions.

Only two determinations were made since the original estimate of the probable atomic weight of this lead proved to be correct and the concordance of the two experiments was all that could be desired. Weighings were made by substitution and the weights of lead chloride and silver were corrected to vacuum by applying for each gram the corrections +0.000058 and −0.000031 g., respectively.

TABLE I

THE ATOMIC WEIGHT OF LEAD

	Ag = 107.880			Cl = 35.457	
Wt. of $PbCl_2$ in vacuum, g.	Wt. of Ag in vacuum, g.	Ag added, g.	Corrected wt. of Ag in vacuum, g.	Ratio $PbCl_2/2Ag$	Atomic wt. of lead
3.74779	2.91798	+0.00010	2.91808	1.28433	206.194
5.63102	4.38431	+ .00005	4.38436	1.28434	206.196
			Average	1.28434	206.195

Wells has analyzed the identical specimen of uraninite from which the lead which we have investigated was extracted and finds 53.52% of ura-

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[2] Baxter and Grover, THIS JOURNAL, 37, 1031 (1915).

[3] Purified by Professor Ishimaru for an investigation on the atomic weight of meteoric nickel, *ibid.* 51, 1729 (1929).

nium, 10.37% of thorium and 9.26% of lead. If one assumes (1) that our material is essentially free from ordinary lead, (2) that the relation of Pb^{206} to Pb^{207} found by Aston in bröggerite material, 86.8 to 9.6, is the relation in which these isotopes are produced from uranium and (3) that the uranium equivalent of thorium in lead-producing power is 0.38, the average atomic weight of the lead in this specimen of uraninite may be calculated to be 206.23. The difference between this value and our experimental value is far larger than the experimental uncertainty.

With Wells' percentages and the thorium-uranium constant, 0.38, together with the experimental value of the atomic weight of the lead in this uraninite, the average atomic weight of uranium lead is found to be 206.06, while Aston's ratio of Pb^{206} to Pb^{207} gives 206.10. On this basis the ratio of Pb^{207} to Pb^{206} would be a little over half as large as that found by Aston.

The assumption of Aston's ratio of Pb^{207} to Pb^{206} in uranium lead together with Wells' percentages of uranium and thorium and the atomic weight of our specimen of uraninite lead makes it possible to calculate the Th/U constant to be 0.27, a value believed by some to be within the bounds of possibility.

The uncertainty of the assumptions makes the last three calculations of doubtful value.

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[Contribution from the Chemistry Department of Coe College]

THE ACTIVITY COEFFICIENT OF COPPER IODATE IN AQUEOUS SALT SOLUTIONS

By Ben H. Peterson and Earl L. Meyers

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Bronsted and La Mer[1] have reduced the Debye and Hückel equation[2] to $-\log f = 0.505\, z_1\, z_2\, \sqrt{\mu}$ as a limiting law which is valid when the ions are separated to such distances that the actual volume occupied by the ions is of no effect. Considerable research has been done testing the validity of this equation by measuring the activity coefficients of slightly soluble compounds in aqueous salt solutions. La Mer and Goldman[3] have determined the activity coefficients of thallous and lanthanum iodates, and Lewis and Randall[4] have calculated them for barium iodate using the data of Harkins and Winninghoff.[5] The slight solubility of

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[1] Brönsted and La Mer, This Journal, **46**, 560–61 (1924).

[2] Debye and Hückel, *Physik. Z.*, **24**, 185–342 (1923).

[3] La Mer and Goldman, This Journal, **51**, 2632–2645 (1929).

[4] Lewis and Randall, "Thermodynamics and the Free Energy of Chemical Substances," McGraw-Hill Book Co., Inc., New York, **1923**, p. 375.

[5] Harkins and Winninghoff, This Journal, **33**, 1827 (1911).