AGE OF THE URANINITE FROM THE McLEAR PEGMATITE NEAR RICHVILLE STATION, ST. LAWRENCE COUNTY, NEW YORK

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The McLear pegmatite, which was discovered in 1907, is located in the Gouverneur Quadrangle, 3.8 miles north 47°45′ east from Richville Station, St. Lawrence County, New York, or at latitude 44°27′32.4″ north and longitude 75°18′39.6″ west, locality 9, Fig. 1.

The mine has been in active operation for a large part of the time since the initial development work, however, during the past two years the property has been temporarily closed down. The pegmatite occurs in highly metamorphosed limestone of the Grenville series[1] and is parallel to the strike of the beds. In 1929 the writer[2] made a detailed study of the pegmatite but did not at that time observe the occurrence of uraninite or any of the decomposition products. In the autumn of 1936 the writer visited the locality and collected a number of specimens, on the dump from shaft number 2, containing small black mineral grains. These were not examined in detail until the spring of 1938 when cubes of uraninite were identified. On subsequent visits to the property, approximately 10 grams of uraninite have been obtained.

Mode of Occurrence and Crystal Habit of the Uraninite

The chief mode of occurrence is that of small cubes, Fig. 2, which measure up to 5 mm. along an edge. The cubes are rarely modified by the rhombic dodecahedron and very rarely by the octahedron. A number of penetration twins, Fig. 3, were observed. The crystals are most commonly imbedded in *white* quartz which is quite unusual, for all previous occurrences observed by the writer at other localities the crystals were associated with smoky quartz. The uraninite is coated with a white material which gives the crystals a rough appearance. The crystals are usually very fresh and unaltered when they occur in quartz, from which they are frequently obtained without much fracturing of the uraninite due to the fact that the quartz is finely fractured throughout the pegmatite. Occasionally the uraninite in the quartz is altered to a black mass which is readily reduced to a powder between the fingers. The feldspar, which is usually a mixture of granular microcline perthite and albite, also occasionally contains grains of uraninite which do not produce any noticeable darkening of the feldspar in contrast to the feldspar of the Canadian pegmatities which is conspicuously colored a reddish brown in

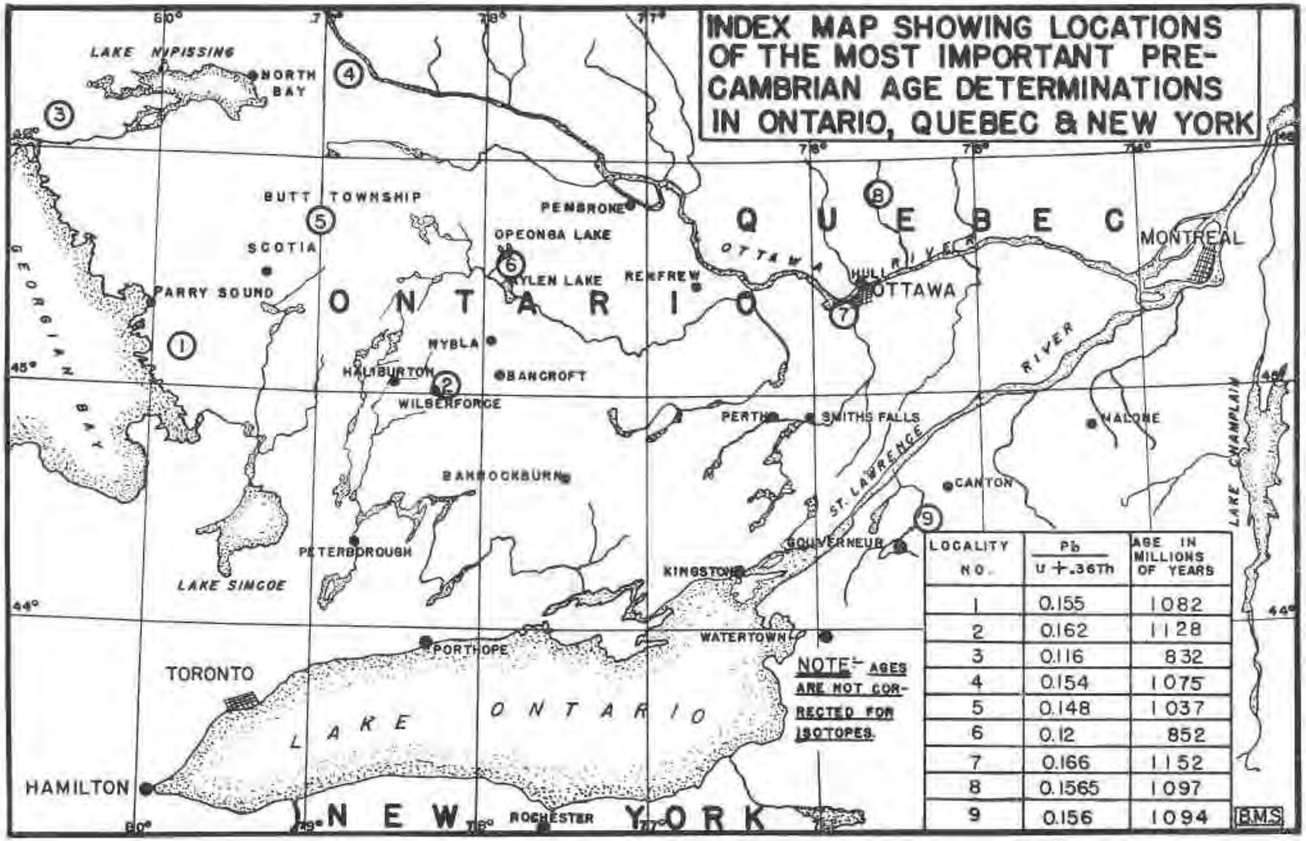

FIG. 1. Map showing locations of occurrences of radioactive minerals in Ontario, Quebec, and New York listed in Table 1.

the vicinity of the uraninite.[3] Irregular grains of uraninite without crystal faces occur imbedded in greenish tremolite crystals which are associated with the quartz and sphene. Both tremolite and sphene are often abundant. The usual orange and yellow alteration products do not occur with the uraninite associated with the quartz, and very rarely with that associated with the tremolite.

One of the common minerals of the pegmatite is diopside which is sometimes altered, especially when it occurs in larger crystals. Associated with the altered diopside crystals and grains, as well as with calcite, one sometimes finds a black radioactive material which is usually powdery and originally may have been uraninite. The material is sometimes rather firm and resembles the thucholite from the Ontario pegmatites. Owing to the very small quantity of the material available a detailed examination has not yet been undertaken. It is hoped that further search may reveal an additional quantity for continued investigation.

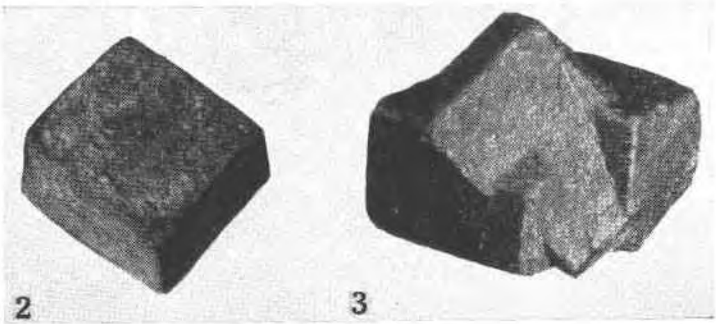

FIG. 2. Uraninite cube from the McLear pegmatite, St. Lawrence County, New York. X=10.
FIG. 3. Twinned uraninite cubes from the McLear pegmatite, St. Lawrence County, New York. X=9.

CHEMICAL COMPOSITION OF THE URANINITE

A number of the freshest looking crystals were tested on photographic plates for their radioactivity, which produced strong radiograms in 36 hours. One of the good crystals was selected for analysis and the rough coating removed by means of fine carborundum cloth, after which it weighed 192 milligrams and had a specific gravity of 9.03. The crystal was sent to Dr. Friedrich Hecht of Vienna for a microchemical analysis. The work was done by Th. I. Koss-Rosenqvist of Oslo under Dr. Hecht's directions. His determinations are as follows:

Insoluble residue after evaporating with HNO_3	0.45%
(of which SiO_2 is)	(0.37)
PbO	11.57
(Pb)	(10.74)
Al_2O_3	0.03
Fe_2O_3	0.92
Rare earths	4.44
CaO	2.50
MgO	1.16
ThO_2	5.20
(Th)	(4.57)
UO_2	75.89
(U)	(66.90)
P_2O_5	trace
H_2O (−)	0.07
H_2O (+)	not determined
S	0.20
"Loss by ignition" increase in weight.	
	102.80

The lead-uranium-thorium ratio $\left(\frac{Pb}{U+0.36\ Th}\right)$ is 0.156.

Although all of the uranium is reported as UO_2, Dr. Hecht states[4] that most of the uranium "seems to be present in the form of UO_2 because increase in weight has been found instead of loss by ignition." He further states that he would not say that the "*whole* uranium would be UO_2."

As very fine-grained pyrite is not uncommon in association with the pegmatite minerals it is not unlikely that the small amount of sulphur present was combined with a corresponding part of the iron as pyrite rather than with ordinary lead in galena. The latter is of extremely rare occurrence in the pegmatite.

Age of the Uraninite

As one cannot determine from the microchemical analyses the amount of ordinary lead that may be present, if any, the entire amount of lead present must be assumed, for purposes of tentative age determination, to be uranium lead. As obtained from the analysis the lead-uranium-thorium ratio $Pb/(U+0.36\ Th)$ is 0.156, which according to Holmes[5] is of Laurentian age, or about the middle of the pre-Cambrian.

The occurrence of uraninite in the McLear pegmatite is believed to be the first to be recorded in the Grenville formation of New York State and is of interest in correlating the ages of the formations of St. Lawrence County with those of Ontario. A tabulation of the ratios determined from the best material investigated, chiefly uraninite, is given in Table 1.

Table 1. Tabulation of Some Lead-Uranium-Thorium Ratios for Areas in Ontario, Quebec and New York

Locality Numbers refer to locations on map, Fig. 1	Mineral analyzed	"Lead-uranium" ratios of the analyses	t = age in millions of years = $15140 \log \left(1+\frac{1.115\ Pb}{U+.36\ Th}\right)$
(1) Conger Township, Parry Sound Dist., Ont. (McQuire-Robinson claim).	Uraninite (*Ellsworth*)[a]	0.155	1082
(2) Wilberforce, Cardiff Township, Haliburton County, Ontario, Lots 4 & 5, Con. 21.	Uraninite (*Ellsworth*, 2 analyses)[b]	0.157 0.172	1097 1195
	(*Todd*)[c]	0.151	1056
	(*Wells*)[d]	0.162	1125
	(*Hecht & Reich-Rohrig*, 2 analyses)[e]	0.173 0.159	1204 1110
	(*Alter & Kipp* 2 analyses)[f]	0.160 0.157	1116 1100
	(*Hecht*)[g]	0.163	1137
	(*Kroupa*)[g]	0.164	1142
		Av. 0.162	Av. 1128
(3) Henvey Township, Parry Sound Dist., Ont. Bessner Mine, Lot 5, Con. B.	Uraninite (*Ellsworth*)[h]	0.116	832
(4) Matawan Township, Nipissing Dist., Ont. O'Brien Mine, Lot 29, Con. 3.	Euxenite-polycrase (*Ellsworth*)[i]	0.154	1075
(5) Butt Township, Nipissing Dist., Ont. Wm. Elliott Mine, Lot 13, Con. 7.	Uraninite (*Ellsworth* 2 analyses[j]	0.148 0.148	1037 1037
(6) Dickens Township, Nipissing Dist., Ont. Armstrong Claim, Lot 9, Con. 13.	Monazite (*Ellsworth*)[k]	0.12	852
(7) March Township, Carlton County, Ont. Lot 6, Con. 2.	Uraninite (*Ellsworth*)[l]	0.166	1152

TABLE 1. TABULATION OF SOME LEAD-URANIUM-THORIUM RATIOS FOR AREAS IN ONTARIO, QUEBEC AND NEW YORK—(Continued)

Locality Numbers refer to locations on map, Fig. 1	Mineral analyzed	"Lead-uranium" ratios of the analyses	t = age in millions of years = 15140 log $\left(1+\frac{1.115\ Pb}{U+.36\ Th}\right)$
(8) Villeneuve Township, Papineau County, Que. Lot 31, Range 1, Villeneuve Mine.	Uraninite (*Hillebrand*)[m] (*Ellsworth*)[n]	0.156 0.157	1094 1100
(9) St. Lawrence County, New York, 3.8 miles N 47°45′ E from Richville Station, McLear pegmatite, No. 2 Shaft.	Uraninite (*Koss-Rosenqvist*)	0.156	1094

[a] Ellsworth, H. V., Radium-bearing pegmatites of Ontario: Summary Report, **1911,** Part D, p. 60, *Geological Survey, Canada Department of Mines, Ottawa, Ontario.*

[b] Ellsworth, H. V., Recent discoveries of radioactive minerals in Ontario: Summary Report, **1923,** Part C1, p. 20, *Geological Survey, Canada Department of Mines, Ottawa, Ontario.*

Ellsworth, H. V., Rare-element minerals of Canada, 268–269 (1932), *Economic Geology Series No.* **11,** *Geological Survey, Canada Department of Mines, Ottawa, Ontario.*

[c] Walker, T. L., Uraninite from Cardiff Township, Ontario: *University of Toronto Studies, Geol. Series* **17,** 43, 1924.

[d] Wells, R. C., Analysis appears in Kirsh, Gerhard, and Lane, Alfred C., Radioactive disintegration applied to the measurement of geologic time illustrated by application to the Wilberforce Uraninite: *Proc. Am. Acad. Arts and Sci.*, **66,** 365 (1931).

[e] Report of the Committee on the Measurement of Geologic Time, p. 21, April 22, **1933,** *National Research Council, Washington, D. C.*

[f] Alter, C. M., and Kipp, Egbert M., The variation of the lead-uranium-thorium ratio of a single crystal from Wilberforce, Ontario, Uraninite: *Am. Jour. Sci.*, **32,** 120–128 (1936).

[g] Report of the Committee on the Measurement of Geologic Time, p. 56, May **1937,** *National Research Council, Washington, D. C.*

[h] Ellsworth, H. V., Uraninite from Henvey Township, Parry Sound District, Ontario: *Am. Mineral.*, **16,** 576–579 (1931).

[i] Ellsworth, H. V., Euxenite-polycrase from Mattawan Township, Nipissing District, Ontario: *Am. Mineral.*, **11,** 329–331 (1926).

[j] Ellsworth, H. V., Rare-element minerals of Canada, 268–269 (1932): *Economic Geology Series, No.* **11,** *Geological Survey Canada.*

[k] Ellsworth, H. V., Monazite colored by carbon from Dickens Township, Nipissing District, Ontario: *Am. Mineral.*, **17,** 19–28 (1932).

[l] Ellsworth, H. V., Rare-element minerals of Canada, 268–269 (1932): *Economic Geology Series,* No. **11,** *Geological Survey Canada.*

[m] Hillebrand, W. F., New analyses of uraninite: *Am. Jour. Sci.*, **42,** 390–393 (1891).

[n] Ellsworth, H. V., Rare-element minerals of Canada, 272 (1932): *Economic Geology Series,* No. **11,** *Geological Survey Canada.*

Many analyses of radioactive minerals of the Grenville area in Ontario were consulted, but unless the material used was believed by the investigators to be essentially free from alteration, they were not included. Some of the analyses of the middle and central parts of crystals which were slightly altered at the surface were included when the results of the analyses were in good agreement. Most of the analyses of uranium-bearing minerals which have a very low percentage of uranium do not give consistent ratios; hence, they were in general not included.

With the exception of the uraninite from the Bessner Mine, locality 3, and the monazite from the Armstrong claim, locality 6, it is of interest to note the close agreement in age between uranium-bearing minerals as widely distributed as shown on the map, Fig. 1. The age of the first two is distinctly younger than the others and they are probably Huronian rather than Laurentian.

The computed ages for the uranium-bearing minerals shown in Table 1, except numbers 3 and 6, show a rather remarkable agreement when one considers the many possible variables which may enter into the final figures. While a large fraction of the variations may be assigned to the probable loss of constituents of the minerals by alteration, nevertheless, there may be a distinct difference in the actual periods when the pegmatite deposits originated, for one would hardly expect the intrusion and crystallization of the pegmatite magmas to be simultaneous over such a large area. Expressed in per cent above and below the average we have 8.75 and 6.3 per cents, respectively. The age of the uraninite from the McLear pegmatite differs from the average by being 1.2 per cent lower.

Nier's[6] determination of the age of the Wilberforce uraninite on the basis of the relative abundance of lead isotopes gives the age from RaG/U^{238} to be 1077×10^6 years and from AcD/RaG to be 1035×10^6 years. These ages differ between themselves and are somewhat lower than the average age (1128×10^6) determined by use of the logarithmic formula.

Acknowledgments

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4. Personal communication.
5. Holmes, Arthur, *The Age of the Earth,* p. 204, Thomas Nelson & Sons, Ltd., London & New York (**1937**).
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