

I. URANOTHORITE FROM THE MACDONALD MINE,  
HYBLA, ONTARIO.

II. ALPHA AND BETA HYBLITE—NEW SULFATIC  
ALTERATION PRODUCTS OF THE HYBLA THORITE

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I. Among some specimens collected from the dump of the MacDonald Feldspar Mine<sup>2</sup> was one which proved to be uranothorite, a new mineral for this mine and in fact the first known occurrence of thorite in Canada.

The specimen consists of aggregates of black crystals set in a mixture of quartz and somewhat decomposed and rusty feldspar. Both quartz and feldspar surrounding thorite are severely fractured, the fractures radiating generally in a direction normal to crystal surfaces. The crystals are typically elongated square prisms varying from one-eighth to one-half inch in cross section, and terminated in many cases by the basal pinnacoid. They are very brittle and cannot be extracted intact from the rock. Most of the thorite crystals in contact with feldspar are superficially altered for a depth of one quarter millimetre or less to a soft, pearly white mineral of about the color and lustre of porcelain. Where thorite is in contact with quartz there is generally little or no alteration product, and the thorite is black and fresh right up to the contact. In some cases part of a single thorite crystal is altered where in contact with feldspar, fresh where enclosed by quartz. On close inspection under the binocular microscope patches of a paper-thin coating of more or less altered pyrite may be seen lining the feldspar in cavities from which thorite crystals have been broken out and also in fractures in the feldspar, while there is little or no pyrite at quartz-thorite contacts. Occasional minute grains of pyrite also occur embedded in the thorite crystals themselves. These have not oxidized. It seems very probable that originally there was a film of pyrite enveloping nearly all the thorite surfaces in contact with feldspar and that the thin layer of thorite alteration products is due to the action of sulphuric acid resulting from the oxidation of the pyrite. (Fig. 1.) Where the alteration has been most intense there is a second alteration

<sup>1</sup> Published by permission of the Director of the Geological Survey of Canada.

<sup>2</sup> *G. S. C. Summary Report (1923)*, Part CI.

product, between the feldspar and the white material. This also occurs only in extremely thin films and minute patches, never over one quarter millimetre thick, and where a crystal has broken out this mineral usually remains attached to the feldspar, whereas the white mineral is more likely to remain attached to the thorite. This alteration product is transparent to translucent, of a yellowish color and resinous lustre, resembling some varieties of allophane in appearance.



FIG. 1.  
Crystal of uranothorite (X 3) showing thin white line of alteration products next to matrix.

That many of the thorite crystals are quite perfectly formed is indicated by various sections exposed where the feldspar with its contained crystals has broken in suitable directions. Nearly all the crystals, however, appear to connect with others at some point, so that the whole might almost be described as a "graphic intergrowth" of thorite with feldspar and quartz.

The thorite is black en masse, in thin sections brownish and isotropic; powder brownish grey. Lustre sub-vitreous to pitchy. Cleavage not apparent, fracture subconchoidal, very brittle. Hardness 4.5 to 5. Sp. Gr.=4.414.  $n=1.710$ .

An analysis of carefully selected crystal fragments free from alteration products yielded the following results:

## URANOTHORITE, MACDONALD MINE, HYBLA, ONTARIO

	Per Cent.	Mol. Wt.	Bases	Acids
PbO.....	1.32	222	0.0059	
(Pb=1.22)				
<sup>238</sup> UO <sub>2</sub> .....	7.67	270.2	0.0284	
UO <sub>3</sub> .....	9.46	286.2	0.0330	
(U=14.63=17.25 U <sub>3</sub> O <sub>8</sub> )				
ThO <sub>2</sub> .....	46.33	264	0.1755	
(Th=40.72x0.38=15.47 U equiv.)				
(Ce, La, Di) <sub>2</sub> O <sub>3</sub> .....	0.08	330	0.0002	
(Yt, Er) <sub>2</sub> O <sub>3</sub> .....	0.36	250	0.0014	
FeO.....	0.43	72	0.0060	
Fe <sub>2</sub> O <sub>3</sub> .....	0.75	159.7	0.0047	
FeS <sub>2</sub> .....	Traces present			
MnO.....	0.07	70.9	0.0010	
Al <sub>2</sub> O <sub>3</sub> .....		102.2	0.0013	
BeO.....	0.13			
CaO.....	4.38	56	0.0782	
MgO.....	<0.01	40.3		
SiO <sub>2</sub> .....	19.56	60.3		0.3244
H <sub>2</sub> O-110°.....	3.57		0.3356	0.3244
H <sub>2</sub> O+110°.....	5.67	18	0.3150	
Insol.....	0.15			
He.....	Not determined.			
	99.94			

Sp. Gr.=4.414 at 22.70°

$n=1.710$

Pb / U+0.38 Th=0.04

\* It was impossible to get consistent results for UO<sub>2</sub> on the main sample due to the presence of traces of pyrite. The value given was obtained on a separate specially selected small sample.

The mineral is evidently a high uranium, high calcium thorite, with apparently a greater content of both U and Ca than any previously known.

In view of the very evident alteration of this mineral it is not surprising that the lead should be low and the apparent age only a small fraction of that indicated by the Ontario uraninites. The Pb/U+0.38 Th ratio is about the same as that determined by Todd<sup>3</sup> for ellsworthite from the same mine. Nevertheless, it is

<sup>3</sup> Walker and Parsons, *University of Toronto Studies*, (1923).

rather remarkable that the two minerals—i.e., thorite and ellsworthite—so different in composition, should even agree as well as they do, granted that both have been greatly altered and leached. There is no geological evidence, however (in the writer's opinion), to indicate that the MacDonald dike is younger than other dikes of the Ontario Precambrian known to be 1100–1200 millions of years old. For instance, uraninite from a somewhat similar calcite-bearing pegmatite on lot 4 con. XXI Cardiff township, Haliburton county, Ontario (the Richardson property), about twenty miles distant yields the normal ratio 0.15. Geologically, the occurrence of considerable quantities of calcite and dark purple fluorite in both dikes as well as in many other pegmatites of the Bancroft area, seems to indicate a close relationship of all of them to one period of intrusion, so that in spite of the low age indications of the ellsworthite and thorite, the writer believes that the MacDonald dike cannot be younger than the Richardson pegmatite just mentioned.

II. The two minerals resulting from sulphatic alteration of the thorite as mentioned in Part I occur in such minute amounts that it was impossible to isolate sufficient quantities for quantitative analysis. Careful qualitative microchemical tests indicated that thorium is the most prominent constituent of both, with uranium apparently next in importance. Iron and small amounts of lead are present, with  $\text{SO}_3$  and  $\text{SiO}_2$  as acids. Carbon dioxide was not detected. As only the most minute quantities could be obtained in approximately pure condition it was impossible to do more than identify the main constituents. Thorium was positively identified in both cases by the formation of the oxalate with oxalic acid in hydrochloric acid solution and by the formation of the peroxy-nitrate precipitate in a neutral nitrate solution. Relatively large Th precipitates were obtained.

Both minerals appear to be hydrous basic sulfo-silicates of thorium chiefly, with minor uranium, iron and lead and quite likely some aluminium and calcium. There does not appear to be an abnormal amount of lead present—i.e., no more than would roughly correspond to the amount present in the thorite itself. These alteration products were examined in the first instance with the idea that they might represent a concentration of lead compounds derived from the thorite, but no evidence was obtained which would indicate the presence of lead in increased amounts.

The sulfate reactions obtained may of course be due solely to lead sulfate though there appeared to be more  $\text{SO}_3$  than would correspond to the lead present. The yellow-brown alteration product in particular might be expected to contain aluminium derived from the feldspar, which also appears to have been considerably attacked by the decomposing pyrite.

The white mineral will be referred to here as alpha-hyblite, the yellow-brown one as beta-hyblite.

Although alpha-hyblite appears opaque, pearly white or porcelainic under the binocular, minute grains when immersed in oils under fairly high power are brownish, transparent to cloudy, isotropic and without visible definite cleavage, though it may have a scaly cleavage or parting. With high power many extremely minute bubbles are visible which perhaps are aggregations of entrapped helium. These bubbles probably contribute largely toward producing the brownish color at lower magnifications, but even with high powers the mineral itself still appears yellowish. The great majority of grains selected at random from different crystals have indices between 1.540 and 1.545 which seems to indicate that most of the material is one fairly definite compound. A few grains which go as high as 1.580 are perhaps transitional to beta-hyblite.

Beta-hyblite under the binocular appears yellowish brown with resinous lustre and conchoidal fracture and is transparent to translucent. It is very brittle and easily scratched by a needle point but is harder than alpha-hyblite. In oils under the microscope it is yellowish to brownish, isotropic and definitely granular whereas alpha-hyblite is powdery or scaly. The beta-hyblite is without bubbles and it also shows no cleavage. The great majority of the grains taken at random have indices between 1.605 and 1.610 not exceeding the latter value.

As the most completely altered yellow thorites listed by Larsen do not go below  $n = 1.68$  it is evident that these two materials are very different in every way from the usual alteration product of thorite.