Geology of the Huron River pitchblende occurrence, Baraga County, Michigan

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Trace Elements Investigations Report 303

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GEOLOGY OF THE HURON RIVER PITCHBLENDE OCCURRENCE, BARAGA COUNTY, MICHIGAN*

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R. C. Vickers

February 1955

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By R. C. Vickers

ABSTRACT

Small quantities of uranium-bearing minerals were discovered by a geologist of the Jones and Laughlin Ore Company during the summer of 1949 along the East Branch of the Huron River, sec. 1, T. 51 N., R. 30 W., Baraga County, Mich. Subsequent diamond drilling of the prospect by the Jones and Laughlin Ore Company and the Ford Motor Company disclosed only minor amounts of radioactive materials at shallow depths in the immediate vicinity of the surface showings.

Pitchblende and secondary uranium minerals occur as very small, discontinuous stringers and pods in calcite and quartz cementing the breccia within a low-angle shear zone that dips about 10 degrees to the southwest. The shear zone has a thickness of 10 to 30 feet and cuts black, locally carbonaceous slates of the upper Huronian Precambrian Michigamme slate.

Mineral deposition during two hypogene stages and one supergene stage was identified in polished sections. The first phase consisted of the introduction of quartz and minor hematite into the sheared slate. After fracturing of the quartz the second stage was initiated by deposition of calcite, pyrite, rutile, pitchblende, bornite, sphalerite, chalcopyrite, galena, and greenockite. The supergene stage consisted of the development of metatyuyamunite, chalcopyrite, chalcocite, covellite, cuprite, volborthite, malachite, and goethite.

Although the known uranium occurrences are restricted to the vicinity of the river gorge, uranium minerals may be present along the westward extension of the shear zone. Because the pitchblende occurs in small, scattered, relatively high-grade concentrations in the shear zone, diamond drilling may have been ineffective in appraising this type of occurrence.

INTRODUCTION

Radioactive minerals containing uranium were discovered during August 1949 along the East Branch of the Huron River, Baraga County, Mich. by Mr. Eiler Hendrickson who was employed as geologist by the Jones and Laughlin Ore Company during the summer months. The discovery was in an area that was suggested as being favorable for uranium mineralization by Mr. L. P. Barrett, at that time chief geologist of the Jones and Laughlin Ore Company.

The prospect was explored jointly during the summers of 1950 and 1951 by the Jones and Laughlin Ore Company and the Ford Motor Company. Forty-one diamond drill holes, aggregating about 3,600 feet, were completed, without favorable results, and further exploration was abandoned.

On behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission, the occurrence was briefly examined by the U. S. Geological Survey during August 1952 and was mapped and reexamined during July 1953. This report concerns the results of field and laboratory study together with most of the available information on the deposit.

Location, accessibility, and ownership

The uranium occurrence is in the NW¼NW¼ sec. 1, T. 51 N., R. 30 W., Michigan Meridian, Baraga County, Mich., and is along the East Branch of the Huron River (fig. 1). The locality is accessible by road from L'Anse, Mich., the nearest town, a distance of 23.6 miles. Most of the observed uranium minerals are on land owned by the State of Michigan although the Ford Motor Company owns the land immediately to the south. A road log from L'Anse, Mich., to the occurrence is as follows:

Miles	
0.0	Intersection of Main and Broad Streets, L'Anse, Mich. Proceed east on Main Street.
15.1	Crossroads, continue straight ahead.
20.2	Junction, bear right.
21.5	Bridge across Huron River.
22.1	Junction, take middle fork.
23.1	Logging road, fork to the right. (A 4-wheel drive vehicle is needed from this point.)
23.3	Ford a tributary of the East Branch of the Huron River. (May be impassable during periods of high water.)
23.6	End of road at the pitchblende occurrence on a bench that has been bulldozed beside the East Branch of the Huron River.

The Huron River pitchblende occurrence is on the northwest flank of the Huron Mountains and is about on the border between the relatively flat lake plain adjacent to Lake Superior to the north and the upland topography of the Huron Mountains to the southwest.

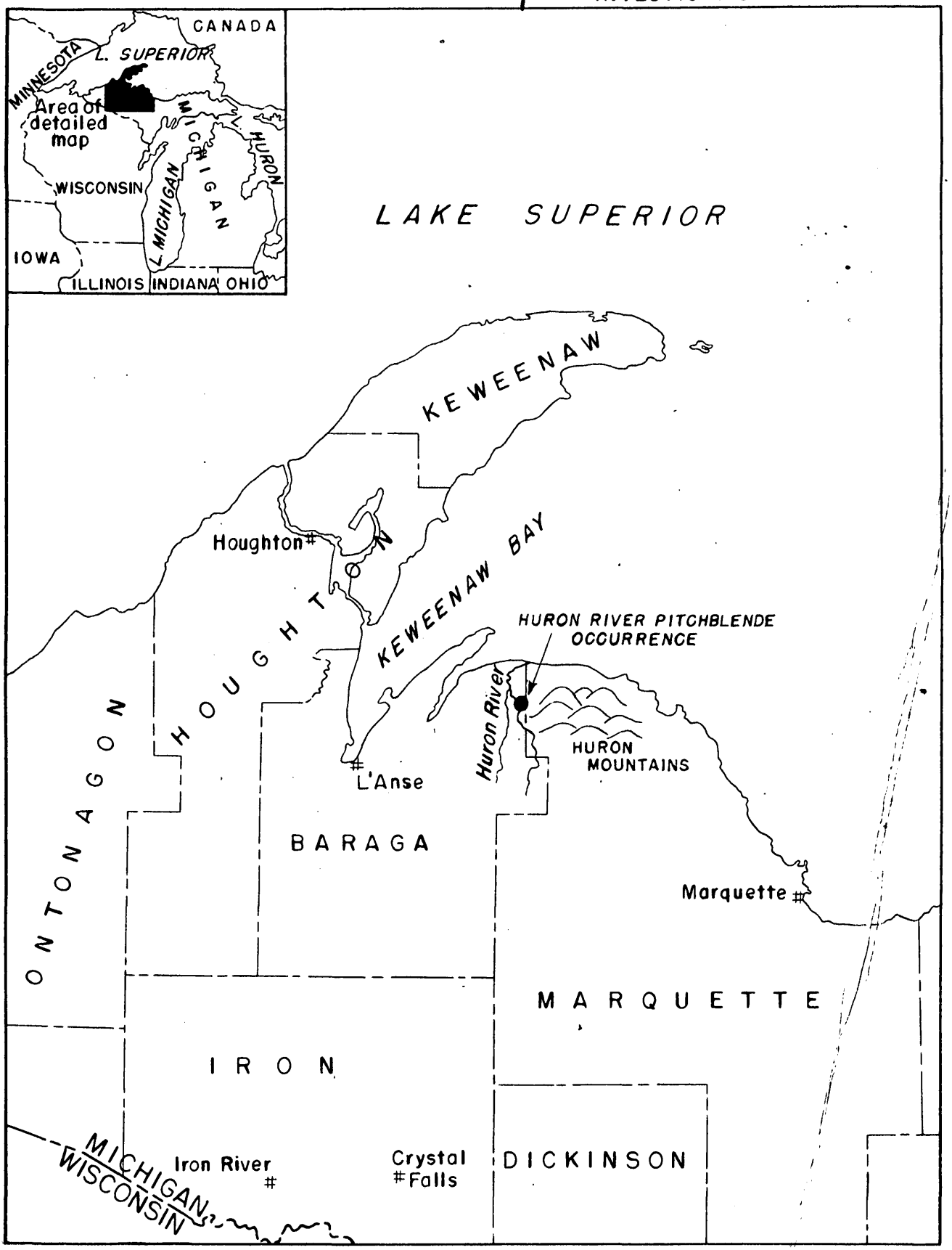

FIGURE 1.-INDEX MAP SHOWING LOCATION OF THE HURON RIVER PITCHBLENDE OCCURRENCE, BARAGA COUNTY, MICHIGAN.

ACKNOWLEDGMENTS

The author is grateful to William M. Fiedler, Chief Geologist of the Jones and Laughlin Steel Corporation, and Robert L. Bodor, Manager, Mining Properties Department, Ford Motor Company, for permission to publish data concerning the results of exploration.

GEOLOGY

General statement

In most of the area the bedrock is covered by glacial deposits and lake sediments, and outcrops are limited to the sides of the gorge which the East Branch of the Huron River has cut in slate.

The Michigamme slate of upper Huronian age is the only formation that crops out in the vicinity of the uranium occurrence. The slate has a regional dip of about 8 degrees to the south.

A low-angle shear zone, probably along a thrust fault, cuts the slates, strikes about N. 36° W., and has an average dip of about 10 degrees to the southwest. The low-angle shear zone and small subsidiary steeply dipping shear zones are marked by masses of brecciated vein quartz and abundant calcite which contain small local concentrations of uranium and copper minerals.

Stratigraphy

The rocks exposed in the vicinity of the uranium occurrence are mainly gray to black slates of the Michigamme slate of upper Huronian age, but older rocks of the same group have been penetrated by drill holes. A

vertical drill hole (DDH-116) penetrated in descending order 835 feet of black and gray slate, 71 feet of cherty iron-formation containing abundant calcite, and about 44 feet of arkose and granite. The arkose-granite contact is exposed about 300 feet downstream from the Huron River bridge, 1.2 miles northwest of the prospect. The arkose is probably the equivalent of the Goodrich quartzite of upper Huronian age, and the slates and cherty iron-formation are part of the great thickness (3,000 to 4,000 feet) of the Michigamme slate, which is composed of slate, graywacke, and thin beds of cherty iron-formation.

The slates exposed at the uranium occurrence range in color from greenish-gray to black. The black slates locally contain a relatively high percentage of carbon.

Structure

The pitchblende occurrences are localized along a group of shear zones, the largest and most prominent of which probably occurs along a thrust fault that strikes about N. 36° W. and dips to the southwest at about 10°. The largest shear zone is about 25 feet thick in the northwestern part of the area shown in figure 2, thickens to about 30 feet where it has been exposed by the river, and thins to about 4 feet in the southeastern part of the area. The thickness and attitude of this shear zone is known mainly from the results of diamond drilling by the Jones and Laughlin Steel Corporation and the Ford Motor Company. Data from the drilling are shown in table 1. Associated with the main shear zone are several subsidiary, narrow, steeply dipping shear zones in the hanging wall. These, in general, strike parallel to the main shear zone and dip 25° to 75° SW. They are probably along high angle reverse faults in the upper block.

Table 1.--Diamond drill core data, Huron River pitchblende occurrence, Baraga County, Michigan 1/

Hole no.	Inclination	Thickness of overburden	Elevation of base of shear zone	Thickness of main shear zone
101	90°	27	634	12
102	90°	3	675	8
103	90°	6	689	8
104	45° N. 35° E.	7	685	10
105	45° N.	2	690	plus 10
106	25° N.	0	690	plus 10
107	10° N.	0	695	plus 8
108	90°	14	687	18
109	90°	17	683	32
110	90°	17	686	22
111	90°	13	678	20
112	90°	15	683	9
113a	30° N.	0	685	20
113b	30° N. 8° E.	0	691	20
113c	30° N. 32° E.	0	695	4
113d	30° N. 25° E.	0	695	4
113e	30° N.	0	693	5
114	90°	23	2/	plus 7
115	90°	2	2/	3/
116	90°	4	2/	3/
117	90°	16	725	plus 4
118	90°	16	719	4
119	90°	15	717	5
120	90°	12	711	5
121	90°	10	707	7
122	90°	10	707	6
123	90°	10	707	8
124	90°	36	714	5
125	90°	35	718	5
126	90°	30	727	4
127	90°	40	727	4
128	90°	44	740	8
129	90°	43	722	3
130	90°	17	676	21
131	90°	15	690	plus 27
132	90°	20	2/	plus 16
133	90°	0	711	7
134	90°	0	722	plus 3
135	90°	0	720	plus 5
136	90°	0	2/	plus 4
137	90°	0	2/	plus 8

1/ Published with permission of the Jones and Laughlin Steel Corporation and the Ford Motor Company.
2/ Base of shear zone not intersected.
3/ Top of shear zone not intersected.

Slaty cleavage is well developed in the exposures along the river upstream from the outcrops of the main shear zone. The cleavage strikes, in general, parallel to the shear zone and dips steeply to the southwest. The strike and dip of the bedding in the slate overlying the shear zone is not uniform and reflects considerable deformation in the upper block, probably caused by folding during and preceding the shearing.

URANIUM OCCURRENCES

Small stringers and pods of pitchblende and fracture coatings of yellow secondary uranium minerals have been identified from surface exposures. The uranium occurrences are in the main shear zone and the subsidiary shear zones.

Gamma-ray logging of the drill holes indicated abnormal radioactivity only in holes intersecting the shear zones at shallow depths in the immediate vicinity of the surface showings.

Mineralogy and paragenetic sequence

A detailed microscopic examination of 15 polished surfaces was undertaken to study the minerals present, to determine the paragenetic sequence of deposition, and to obtain information concerning the geologic and geochemical conditions that influenced the uranium deposition.

The mineral assemblage includes mainly primary and secondary uranium and copper minerals in a quartz-calcite gangue. The primary metallic minerals, even where they are relatively concentrated in the shear zones, make up a small percentage of the rock. Most of the polished surfaces, selected for their metallic mineral content, contained less than 10 percent sulfides which generally were finely disseminated with individual grains

rarely measuring more than 1 mm in diameter. The most abundant primary metallic mineral observed was chalcopyrite, followed in order of decreasing abundance by pitchblende, pyrite, bornite, galena, greenockite, sphalerite, and rutile.

Mineral deposition took place during two hypogene stages and one supergene stage. The first phase was brecciation of the slate and introduction of vein quartz and minor hematite. After fracturing of the vein quartz the second phase was the introduction of calcite, pyrite, rutile, pitchblende, bornite, sphalerite, chalcopyrite, galena, and greenockite. The supergene minerals are metatyuyamunite, chalcopyrite, chalcocite, covellite, cuprite, volborthite, malachite, and goethite.

The paragenetic sequence of mineral deposition is shown in table 2. Because of the very fine grain of most of the minerals and the lack of distinct cross-cutting relationships between many of the minerals, the author believes that the metallic minerals were deposited very rapidly, possibly owing to a steep temperature gradient.

The pitchblende was identified by X-ray powder photographs of material selected by correlating nuclear track plate patterns with a light-gray mineral of colloform structure. Metatyuyamunite and volborthite were also identified by X-ray powder photographs. The other minerals were identified mainly by their physical properties, optical properties in reflected light, etch reactions, and qualitative microchemical tests.

Table 2. Paragenetic sequence of the minerals at the Huron River pitchblende occurrence, Baraga County, Michigan

	Hypogene stages		Supergene stage
	First	second	
Quartz	———		
Hematite	———		
Fracturing			
Calcite		———	
Pyrite		——	
Rutile		——	
Pitchblende		——	
Bornite		——	
Sphalerite		——	
Chalcopyrite		——	
Galena		——	
Greenockite		——	
Metatyuyamunite			———
Chalcopyrite			——
Chalcocite			——
Covellite			——
Cuprite			——
Volborthite			——
Malachite			——
Goethite			——

Uranium minerals

Pitchblende.-- Pitchblende occurs as small rounded blebs commonly from 0.01 mm to 0.1 mm in diameter and as larger irregular masses as much as 1.0 mm in diameter in calcite. Most of the pitchblende blebs contain small grains and idiomorphic crystals of galena. A few of the individual blebs of pitchblende are rimmed by chalcopyrite. The pitchblende is commonly present along the margins of calcite veinlets, and some of it is veined by chalcopyrite, galena, and later calcite.

Semiquantitative spectrographic analyses of an impure specimen of pitchblende containing copper sulfide showed the following elements (spectrographic analyses by R. G. Havens, U. S. Geological Survey).

	Percent
U, Cu, Si	x.+
Pb, Ca	x.
Fe	x.
Cd	o.x+
Al, Mg, Y	o.x
Mn, Ce, V	o.x-
La, Nd	o.ox+
Ba, Cr	o.ox
Ag, Mo, Sc, Zr	o.ox-
Be, Sr, Ni	o.oox-

Metatyuyamunite.-- A yellow-green, non-fluorescent, microcrystalline, uranium mineral is present as fracture-coatings at locality A (fig. 2). The mineral gives a good X-ray powder photograph that matches very closely powder photographs of metatyuyamunite from Ferghanna, Turkestan, and the X-ray data metatyuyamunite given by Weeks and Thompson (1954, p.37-38). Semiquantitative spectrographic analyses of impure material showed the following results:

Over 10 percent	Cu, U
1 - 10 percent	Si, V, Fe, Ca

The silicon, iron, and copper in the spectrographic analyses are probably impuriites.

The metatyuyamunite is closely associated with malachite and volborthite.

Description of localities

Pitchblende and metallic sulfides have been found as small veinlets and local concentrations in quartz-and calcite-cemented brecciated shear zones for a distance of about 600 feet along the course of the East Branch of the Huron River (localities A, B, C, D, and E). Secondary uranium and copper minerals have been found within the main shear zone at locality A. The location of these occurrences is shown in figure 2.

At locality A several narrow zones of secondary uranium and copper minerals were exposed by stripping off a thin layer of alluvium. At the surface 5 feet south of drill hole 137, secondary uranium and copper minerals were found in a zone about 1 foot wide and 3 feet long. The strike of this zone is about N. 75°W., and the dip is steeply to the southwest. A similar zone of secondary uranium and copper minerals occurs just east of drill hole 136. In each of these occurrences metatyuyamunite coats fractures in calcite and quartz breccia. Selected samples of material from the two localities contained 0.98 and 0.84 percent uranium. Only a few hundred pounds of material of this grade was evident from the surface showings.

Diamond drilling in the vicinity of locality A indicate four similar zones of uranium mineralization at shallow depths of from 0 to 12 feet (diamond drill holes 115, 134, and 136, and 137. The results of gamma-ray logging of these holes are shown in table 3.

Table 3. Results of gamma-ray logging, Huron River pitchblende occurrence, Baraga County, Michigan*

Hole no.	Elevation of collar (ft)	Inclination and direction	Counts per minute	Vertical depth below bedrock surface to radioactive zone(ft)
105	702.5	45° N.	400-1550	0-7
106	702.5	25° N.	1430	20
107	704.0	10° N.	800	21
109	737.5	Vertical	725	30
115	724.5	Vertical	3000	0-2
134	725.0	Vertical	800	5
136	725.0	Vertical	250-650	0-8
137	725.0	Vertical	500	12

Gamma count in unmineralized shear zone material 60-200 counts per minute.

* Gamma-ray logging by the Jones and Laughlin Ore Company.

At locality B small concentrations of pitchblende with small amounts of metallic sulfides are near the base of the main shear zone. Selected samples from this locality contain as much as 10 percent uranium, and several specimens containing relatively unaltered pitchblende were obtained. The concentrations of pitchblende are in veinlets and masses of calcite and are traceable on the surface for distances of 6 inches to 2 feet. Only a few pounds of material of ore grade was present at each radioactive spot. Gamma-ray logging of the drill holes in the vicninty of locality B indicated small anomalies at shallow depths. The results of the gamma-ray logging of these holes is shown in table 3 (holes 105, 106, 107, and 109).

The other uranium occurrences (localities, C, D, and E) are along subsidiary steeply shear zones in the upper block and are similar to those described at locality B.

The surface exposures, which are limited to the immediate vicinity of the gorge, indicate that the concentrations of uranium, although of a high grade, are small and irregularly scattered within the shear zones.

Wall-rock alteration

Wall-rock alteration is believed to be virtually absent at the Huron River pitchblende occurrence. Many small quartz-calcite veinlets cut unaltered black slate and possess very sharp contacts. Unaltered black slate is also present immediately adjacent to the larger shear zone. Although green slate is present in zones adjacent to some of the shear zones, the green color is believed to have been caused by weathering, localized in some places along the more permeable shear zones. Most of the green slate penetrated in the diamond drilling occurred within 20 feet of the bedrock surface.

"Red alteration" consisting of brick-red vein quartz is closely associated with the pitchblende occurrences and also was found in much of the barren shear zone material in the drill core. The red color is believed to be caused by finely divided hematite in the quartz and may represent an early stage of quartz-hematite mineralization that is characteristic of many of the Canadian pitchblende deposits (Lang, 1952, p. 25-27).

The red color is not a true alteration of the wall rocks but is either caused by the introduction of the brick-red quartz or by the replacement of part of the vein quartz by later finely divided hematite.

Botanical prospecting

The projected outcrop of the shear zone (fig.2) is covered by glacial deposits composed mainly of sand and gravel which diamond drilling showed to be from 15 to 30 feet thick in most of the area away from the river. To determine if concentrations of uranium and/or copper in vegetation overlying the mineralized sheer zone could be used as a prospecting technique, fifteen samples of hemlock needles and twigs (new growth) were collected from the larger hemlock trees growing on the outcrops of the mineralized shear zone at locality A and also from hemlock trees growing on and away from the projected outcrop of the shear zone. The results of analyses of these samples showed that there was no significant concentration of uranium or copper in either the trees growing on the mineralized outcrop at locality A or those growing on glacial material along the projected outcrop of the shear zone. All the samples contained from 0.3 to 0.8 ppm uranium in the ash and from 100 to 150 ppm copper in the ash. No correlation was apparent between the uranium and copper contents.

CONCLUSIONS

Study of the Huron River pitchblende occurrence has shown that pitchblende and base metal sulfides occur as small concentrations localized along brecciated shear zones and that the sequence of deposition consisted of the introduction of vein quartz followed by brecciation and deposition of calcite and the metallic minerals.

It is of interest to note that the vanadates, metatyuyamunite and volborthite have been derived from weathering of the primary minerals although vanadium is only a minor constituent of the primary vein material.

The lack of outcrops along the projected extension of the main shear zones makes determination of the extent of uranium mineralization difficult. Diamond drilling seems to have indicated that the bulk of the uranium minerals occurs in the shear zone where it is exposed along the river. However, because the occurrences are small, discontinuous, relatively high-grade concentrations of pitchblende, diamond drilling may have been ineffective in giving a true representation of the pattern of uranium mineralization.

Drill data indicate that the shear zone thins to about 4 feet in the southeastern part of the mapped area but maintains a thickness of about 20 feet or more in the northwestern part of the area. Thus it would appear that any further exploration of the area should be to the northwest where, if sufficiently mineralized, the shear zone might constitute an ore body.

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