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AN OCCURRENCE OF METATORBERNITE

BARAGA COUNTY, MICHIGAN

By R. C. Vickers

[redacted]

Trace Elements Memorandum Report 741

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

IN REPLY REFER TO:

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WASHINGTON 25, D. C.

AEC - 774/6

May 21, 1956

Mr. Robert D. Nininger, Assistant Director
Division of Raw Materials
U. S. Atomic Energy Commission
Washington 25, D. C.

Dear Bob:

Transmitted herewith are three copies of TEM-741, "An occurrence of metatorbernite, Baraga County, Michigan," by R. C. Vickers, March 1955.

The information in this document will be incorporated in a summary report on the occurrences of uranium in northern Michigan, which is planned for publication as a Geological Survey bulletin.

Sincerely yours,

for W. H. Bradley
Chief Geologist

Geology and Mineralogy

This document consists of 14 pages.
Series A

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

AN OCCURRENCE OF METATORBERNITE BARAGA COUNTY, MICHIGAN*

By

R. C. Vickers

March 1955

Trace Elements Memorandum Report 741

*This report concerns work done on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission.

USGS -TEM-741

GEOLOGY AND MINERALOGY

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TEPCO, RPS, Washington, (including master)	2
	44

CONTENTS

ILLUSTRATIONS

TABLE

AN OCCURRENCE OF METATORBERNITE, BARAGA COUNTY, MICHIGAN

By R. C. Vickers

ABSTRACT

Minute crystals of metatorbernite were found on slickensided surfaces of a kaolinized dike, about 4 feet wide, that cuts graphitic slate of the upper Huronian (Precambrian) Michigamme slate. The altered dike, which is exposed only in an abandoned graphite quarry in the central part of Baraga County, has an abnormally high content of uranium throughout its exposed length of about 240 feet, but the highest concentrations of uranium were found at the quarry floor in the most recently worked part of the quarry. Channel samples of the dike contained from 0.005 to 0.037 percent uranium.

Although conclusive evidence for the origin of this occurrence was not found, the author believes that the uranium has been derived from the adjacent uranium-bearing black slates by leaching under near-surface oxidizing conditions and redeposited under localized reducing conditions. The dike, which may have been kaolinized through weathering processes, provided a channelway for downward moving meteoric water into a reducing environment.

INTRODUCTION

Abnormal radioactivity associated with an altered dike in a graphite quarry in Baraga County, Mich., was found by L. P. Barrett, U. S. Atomic Energy Commission. A subsequent scintillation-counter survey of the quarry by the author showed high gamma counts in a small covered area of the quarry floor along the strike of the altered dike. A shallow trench that was dug across the altered dike in the area of the highest gamma count disclosed minute crystals of metatorbernite on fracture surfaces in the dike. The quarry was then mapped with a plane table and alidade, and the occurrence was studied for the purpose of obtaining additional information concerning uranium in northern Michigan. This work was done by the U. S. Geological Survey on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission.

Location, accessibility, and general features

The graphite quarry is about 7.5 miles south of L'Anse, the nearest town, and is a quarter of a mile west of the mutual east corner of secs. 9 and 16, T. 49 N., R. 33 W., Baraga County, Mich. (fig. 1). A road log to the quarry is given below:

0.0 Corner main and Broad Streets, L'Anse, Mich. Proceed south on Broad Street and continue south on U. S. Highway 41.

3.1 Railroad crossing.

3.5 Junction, take road to left.

8.0 Junction, take logging road to left.

9.5 End of road at quarry.

The area surrounding the quarry is heavily wooded and topographically consists of low, rolling hills. No outcrops are known in the immediate vicinity of the quarry, because most of the bedrock is covered by glacial deposits. The depth of overburden exposed in the quarry ranges from a few feet to about 20 feet.

The quarry has been a source of graphite since the 1880's. Most of the graphite is the amorphous variety and has been used mainly in the manufacture of paint. Some mining of graphitic slate was done in 1950 and 1951, but since that time the quarry has been idle. At the present time that part of the quarry in section 9 is owned in fee by the Ford Motor Company; the Detroit Graphite Company owns the mineral rights in the southern part of the quarry in section 16.

Acknowledgments

The writer wishes to acknowledge the cooperation of R. L. Bodor, Ford Motor Company, in permitting the publication of a company map showing the geology in the vicinity of the quarry and in allowing access to other unpublished information. R. C. Reed, Geological Survey Division, Michigan Department of Conservation, was very helpful in providing the author with information concerning the history of the quarry and analyses of the slate for carbon and iron.

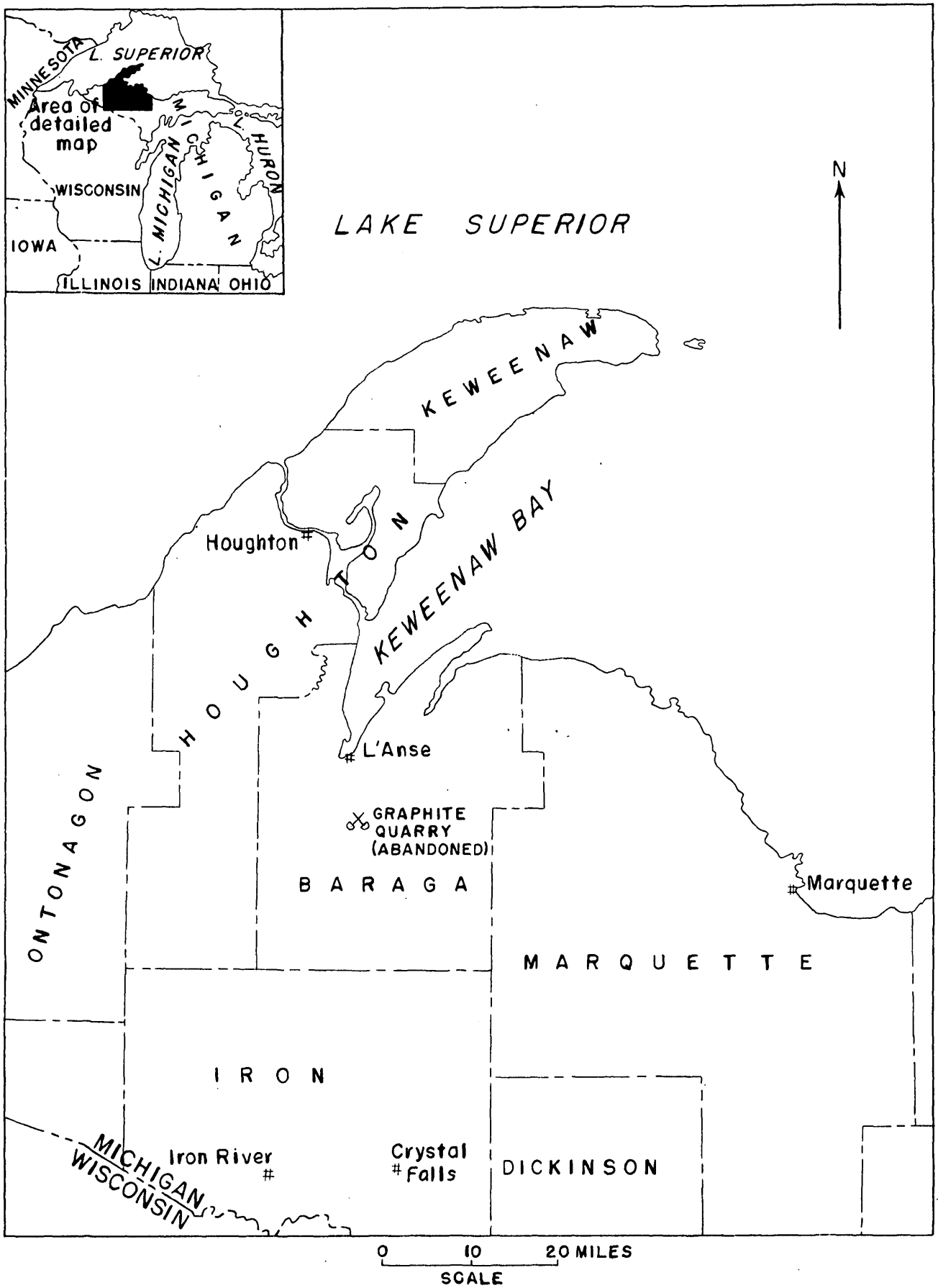

FIGURE 1.–INDEX MAP SHOWING LOCATION OF GRAPHITE QUARRY, BARAGA COUNTY, MICHIGAN

The writer is further indebted to L. P. Barrett, U. S. Atomic Energy Commission, who brought the locality to the attention of the author. J. H. Eric, U. S. Geological Survey, assisted in the field work during August 1954.

GENERAL GEOLOGY

The Precambrian rock exposed in the quarry is mainly graphitic slate that is cut by a narrow kaolinized diabase dike. The rocks in the vicinity of the quarry are granite, believed to be of pre-Huronian age, overlain by graywacke, slate, and iron-formation of the upper Huronian Michigamme slate. These rocks have been cut by westward-trending diabase dikes. (See fig. 2.)

Michigamme slate

The graphitic slate exposed at the quarry is uniformly black with few observable sedimentary features indicative of bedding. Adjacent to the dike the slate is moderately sheared and crumpled. The graphite is present as disseminations and also as thin films along closely spaced slickensided surfaces. Pyrite is visible megascopically as small veinlets, fracture-fillings, and disseminated crystals.

The results of analyses of chip samples of the slate, representing an interval of about 50 feet measured perpendicular to the cleavage, showed a uniform uranium content of 0.003 to 0.004 percent. The slate contains about 30 percent carbon and about 3 to 7 percent iron. _/

Diabase dikes

Fresh diabase dikes cut the slates and iron-formation in the vicinity of the quarry. Thin sections of a dike about 850 feet west of the quarry showed mainly feldspar (andesine), augite (partly altered to hornblende), and abundant magnetite. This rock is classified as a diabasic diorite.

_/ Written communication, R. C. Reed, Geological Survey Division, Michigan Department of Conservation.

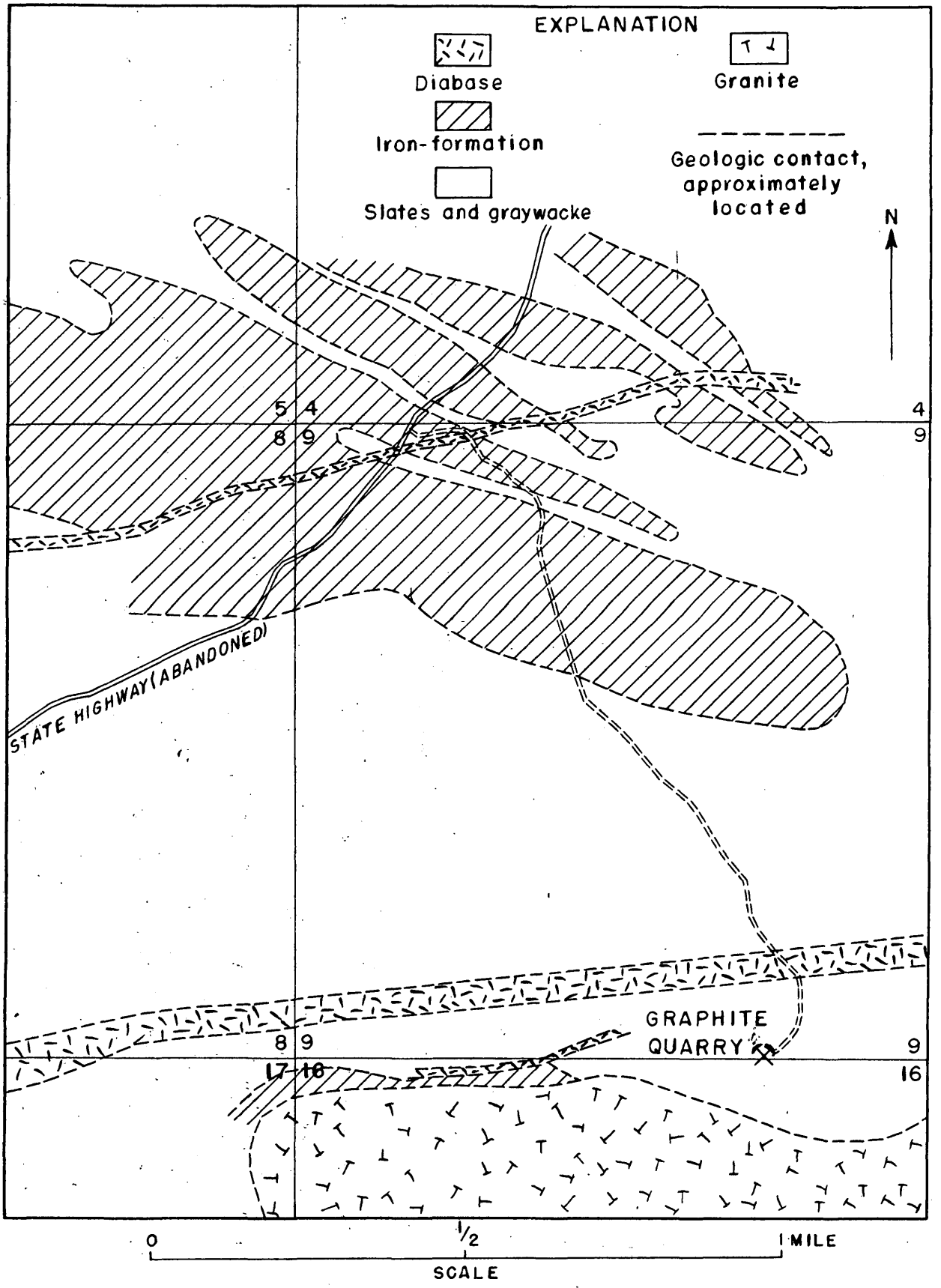

FIGURE 2.–GEOLOGIC MAP OF PART OF T.49N., R.33W., BARAGA COUNTY, MICHIGAN

Map furnished by the Ford Motor Company and published with their permission

An altered diabase dike about 4 feet wide intrudes the slate in the quarry, strikes N. 60° W., and dips 65° SW. A split from this dike is from 0.8 foot to 1.2 feet thick, strikes about N. 80° W., and dips 50° SW. On freshly broken surfaces the dike ranges from dark red to almost white. Thin sections of the reddish material show a diabasic texture of kaolinized feldspar grains and iron oxides which represent altered ferromagnesian minerals. The more altered whitish dike material consists mainly of kaolinite, which was identified by X-ray powder photographs, and relatively unaltered magnetite grains.

GEOLOGIC STRUCTURE

Iron-formation in the black slate about 1 mile northwest of the quarry was explored and mined during the 1880's. Mapping by geologists for the Ford Motor Company has recently shown that the beds of iron-formation are tightly folded, and they are believed to be narrow infolded synclines, the axes of which trend about N. 65° W. (fig. 2). Fresh-appearing diabase dikes, as much as 300 feet wide and traceable by outcrops for distances greater than several miles, cut both the iron-formation and the slate. These dikes strike about N. 80° E. and cut across the axes of folding in the iron-formation and slate (fig. 2).

At the quarry the strike of the cleavage in the slate ranges from west to N. 60° W. and averages about N. 75° W. This direction is in general parallel to the axes of folding in the iron-formation to the northwest. The strike of the altered dike at the quarry is N. 60° W., and thus is in general parallel to the strike of cleavage in the adjacent slates but not parallel to the trend of the other dikes in the area. It is probable then that the altered dike is of an entirely different age than the fresh diabase dikes. Because of the similar structural trends, the altered dike is probably related to the folding of the upper Huronian slates and iron-formation and may be pre-Keweenawan and post-Huronian in age as compared to a Keweenawan age for the fresh diabase dikes.

URANIUM OCCURRENCE

Minute crystals of metatorbernite (hydrous copper uranium phosphate) are disseminated along slickensided surfaces in the kaolinized dike near the hanging wall at locality A (fig. 3). The metatorbernite occurs as light-green thin square basal plates that measure about 0.4 mm on a side. The identification of the metatorbernite was confirmed by X-ray powder photographs and positive microchemical tests for copper and phosphorous. Small grains of pyrite were also identified in those specimens containing the metatorbernite.

A selected sample of metatorbernite-bearing dike rock at locality A (fig. 3) contained 0.052 percent equivalent uranium and 0.068 percent uranium. The sample was found at the quarry floor in that part of the quarry which has been most recently worked (1951). Channel samples of the altered dike contained from 0.005 to 0.037 percent uranium. A sample of unaltered diabase taken about 850 feet west of the quarry contained less than 0.001 percent uranium. Chip samples of graphitic slate from the quarry contained 0.003 to 0.004 percent uranium except one sample of slate, taken adjacent to the hanging-wall contact at locality A, which contained 0.006 percent uranium.

At locality B a narrow quartz vein about 3 to 4 inches wide exhibited abnormal radioactivity. A sample of the radioactive vein quartz contained 0.028 percent equivalent uranium and 0.007 percent uranium. The strike of the vein (N. 70° W.) is parallel with the strike of the dike, but the dip is about 35° N. Pyrite and iron oxides were the only minerals observed in the vein quartz.

The location of the samples and their uranium contents are shown in figure 3, and the results of equivalent uranium and uranium analyses are shown in table 1.

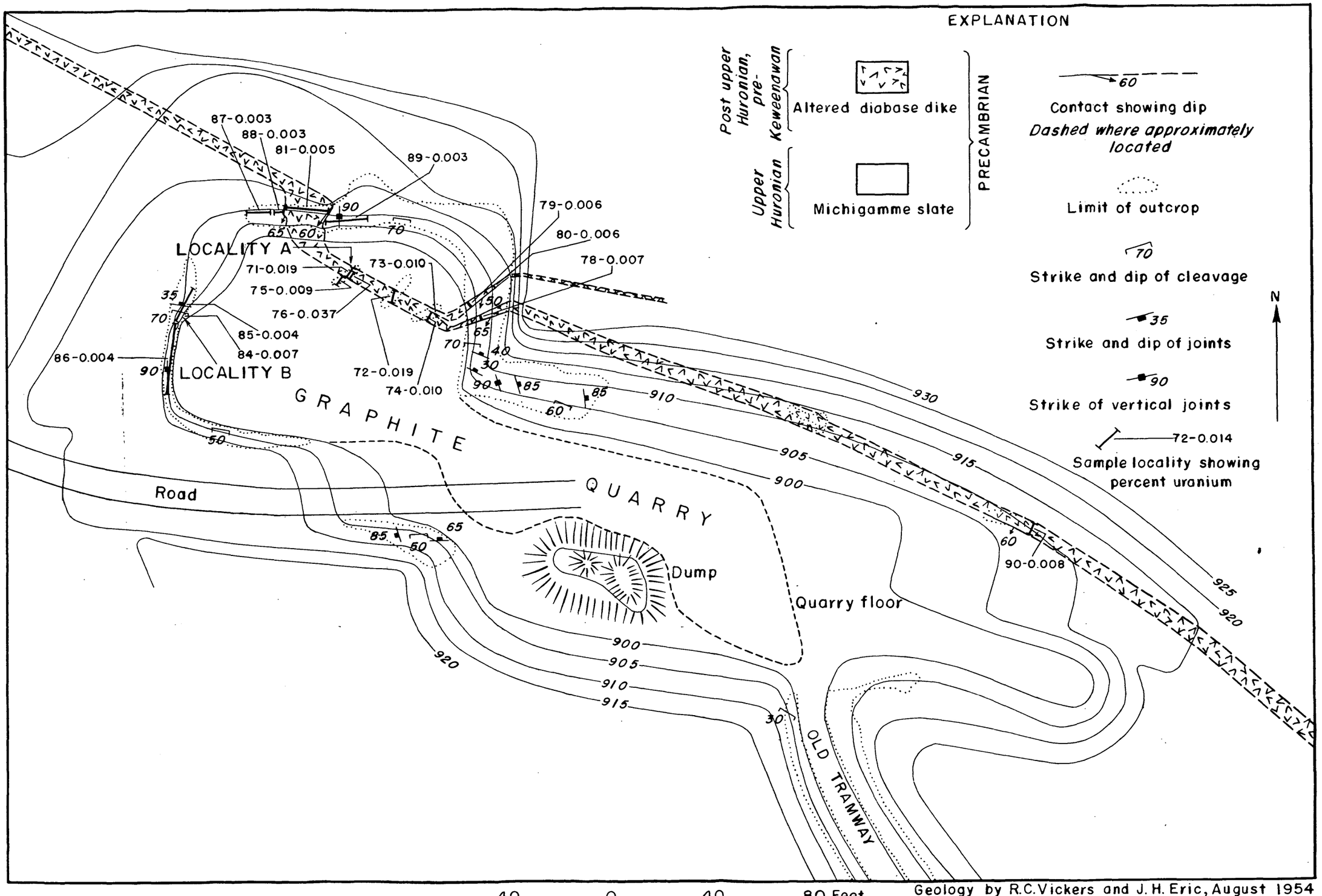

FIGURE 3.—GEOLOGIC MAP OF THE GRAPHITE QUARRY, SEC. 9 AND 16, T.49N., R.33W., BARAGA COUNTY, MICHIGAN

Table 1.--Results of uranium and equivalent uranium analyses of samples taken at the graphite quarry, Baraga County, Michigan. (Analyses by J. W. Patton, J. W. Meadows, and J. P. Schuch, U. S. Geological Survey.)

Sample no.	eU	U	Description
MB-70-53	0.052	0.068	Selected sample of altered dike containing visible metatorbernite at locality A.
MB-71-53	0.023	0.019	4-ft channel sample across dike at locality A.
MB-72-53	0.014	0.019	4-ft channel across dike.
MB-73-53	0.015	0.010	1-ft channel across north split.
MB-74-53	0.009	0.010	3-ft channel sample south dike.
MB-75-53	0.014	0.009	6-inch channel of hanging-wall slate, locality A.
MB-76-53	0.033	0.037	2-ft channel sample across most radioactive part of dike at locality A.
MB-78-53	0.012	0.007	1.2-ft. channel of south dike taken 5 ft above quarry floor.
MB-79-53	0.009	0.006	1.4-ft channel sample of dike, taken 5 feet above quarry floor.
MB-80-53	0.009	0.006	0.8-ft. channel of north dike taken 8 feet above quarry floor.
MB-81-53	0.007	0.005	4-ft channel sample of dike taken 7 feet above quarry floor.
MB-84-53	0.028	0.007	Selected sample of radioactive vein quartz, locality B.
MB-85-53	0.006	0.004	13-ft chip sample of black slate, west end of quarry.
MB-86-53	0.007	0.004	20-ft chip sample of black slate, west end of quarry.
MB-87-53	0.008	0.003	6-ft chip sample of black slate, northwestern part of quarry.
MB-88-53	0.005	0.003	2.5-ft chip sample of black slate, adjacent to dike on hanging wall, northwestern part of quarry.
MB-89-53	0.005	0.003	13-ft channel sample of black slate, adjacent to dike on footwall, northern part of the quarry.
MB-90-53	0.008	0.008	2-ft channel sample of dike, east end of quarry.

CONCLUSIONS

Abnormal amounts of uranium in the altered dike throughout its exposed length of about 240 feet suggest the possibility that uranium may be present for a considerable distance outside the mapped area shown in figure 3.

The abnormal uranium content of the slate adjacent to the altered dike at locality A and the uranium associated with vein quartz, pyrite, and iron oxides at locality B suggest that the uranium has been introduced by solutions that may have been either hydrothermal or meteoric. If meteoric waters have been the cause of alteration of the dike, the same solutions may have leached uranium from the slate under surface oxidizing conditions and deposited it in and adjacent to the weathered dike. The dike could therefore have provided a channelway for solutions to move downward into a midly reducing environment that would favor the precipitation of uranium. The vein quartz and pyrite at locality B are suggestive of a hydrothermal origin; however, abundant hydrous iron oxides were present, suggesting near-surface alteration effects.

From a detailed study of several occurrences of both primary (pitchblende) and secondary uranium minerals in upper Huronian rocks in northern Michigan, the author believes that the uranium and associated elements have been derived from the adjacent uranium-bearing slates by leaching under near-surface oxidizing conditions and redeposition as pitchblende under localized reducing conditions. The secondary uranium minerals, such as the metatorbernite at the graphite quarry have probably been derived from the oxidation of pitchblende during the present weathering cycle.

The time of alteration (weathering) of the kaolinized dike is probably post-Huronian and pre-Keweenawan. The time interval represented by the unconformity separating Keweenawan rocks from the more folded and metamorphosed Huronian rocks is believed sufficient for such weathering processes to have operated. A pre-Keweenawan age for the altered dike explains why this one dike, that is conformable to Huronian structures, is altered, whereas other dikes, that cut across the Huronian structures, are relatively fresh.

It is entirely probable that small quantities of material containing more than 0.1 percent uranium may be present at shallow depths either within the mapped area or along the strike of the dike outside the mapped area. It seems unlikely that the quarry was opened along the dike coincident with the greatest concentration of uranium. The occurrence of other uranium-bearing altered dikes in the area is also possible.