Geology and Mineralogy

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Series A

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

OCCURRENCES OF URANIUM AT CLINTON, HUNTERDON COUNTY, NEW JERSEY *

By

F. A. McKeown, Harry Klemic, and P. W. Choquette

March 1954

Trace Elements Investigations Report 382

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

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GEOLOGY AND MINERALOGY

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A. E. Weissenborn, Spokane	1
TEPCO, Denver	2
TEPCO, RPS, Washington	2
(Including master)	64

CONTENTS

ILLUSTRATIONS

TABLES

OCCURRENCES OF URANIUM AT CLINTON, HUNTERDON COUNTY, NEW JERSEY

by F. A. McKeown, Harry Klemic, and P. W. Choquette

ABSTRACT

An occurrence of uranium at Clinton, Hunterdon County, N. J. was first brought to the attention of the U. S. Geological Survey when Mr. Thomas L. Eak of Avenel, N. J. submitted to the Survey a sample containing 0.068 percent uranium. Subsequent examinations of the area around Clinton indicated that detailed mapping and study were warranted.

The uranium occurrences at Clinton are in or associated with fault zones in the Kittatinny limestone of Cambro-Ordovician age. The limestone is generally light gray, thick bedded, and dolomitic; chert is common but not abundant. Regionally and locally, faults are the most significant structural features. The local faults at Clinton are the loci for most of the uranium. The largest fault can be traced for about 700 feet and is radioactive everywhere it crops out. Samples from this fault contain as much as 0.038 percent uranium; the average content is about 0.010 percent uranium. Uranium also occurs disseminated in two 4-inch layers of black feldspathic dolomite and in several zones of residual soil derived from the Kittatinny limestone. The black layers contain as much as 0.046 percent uranium and can be traced only about 20 feet along strike. They are cut by a small fault that is also radioactive. The radioactive soil zones are roughly elongated parallel to bedding. Soil from them contains up to 0.008 percent uranium. The uranium occurrences are best explained by a supergene origin.

The sampling, mapping, and radioactivity testing of uranium occurrences at Clinton indicate they are too low grade to be of current economic interest.

INTRODUCTION

Uranium occurs in dolomitic limestone and in fault zones that cut the limestone in the vicinity of the Mulligan quarry at Clinton, Hunterdon County, N. J. (fig. 1). The occurrences were first brought to the attention of the Geological Survey when Mr. Thomas L. Eak of Avenel, N. J. submitted a sample to the Survey. The sample contained 0.068 percent uranium. R. U. King and V. R. Wilmarth (1950) of the

Geological Survey briefly examined the quarry in November 1950. R. H. Stewart (1951) made carborne traverses for radioactivity of all accessible roads around Clinton. F. A. McKeown and H. Klemic (1953, p. 20) made a survey for radioactivity of the quarry and surrounding area in 1952. These surveys showed the presence of many radioactivity anomalies that warranted further study and mapping. Consequently, in 1953 an area of approximately 1,200 by 1,000 feet was mapped (fig. 2) at a scale of 1:1200 with plane table and alidade. Nearly every accessible outcrop within the mapped area and many in the surrounding area were tested with a scintillation counter or Geiger counter. An area approximately 500 feet square was tested at 50 feet intervals with a scintillation counter; lines representing equal intensity of radioactivity (isorads) were interpolated from this grid survey (fig. 2).

Mulligan quarry is owned and operated by Michael C. Mulligan of Clinton. During 1953, Mr. Mulligan quarried several tons of limestone a week to supply local needs. The limestone is reported to be excellent for agricultural purposes and road metal. Monroe F. Demotte and Walter Busher, both of Clinton, also own part of the area mapped. As it was not the purpose of this investigation to make a land survey, property lines are not shown on figure 2.

The authors wish to thank Messrs. Mulligan, Demotte, and Busher for their courtesy and cooperation. The investigation was made on behalf of the Division of Raw Materials of the Atomic Energy Commission.

GEOLOGY

The uranium occurrences at Clinton are in the Kittatinny limestone of Cambro-Ordovician age. The limestone is part of a complex of highly folded and faulted Paleozoic rocks that are bounded on the east, west, and south by Triassic rocks and on the north by crystalline rocks of pre-Cambrian age. This Paleozoic complex underlies approximately 80 square miles, and its position is unique in New Jersey. Normally, the southeastern border of the pre-Cambrian rocks is in fault contact with Triassic rocks (fig. 1). In the Clinton area, however, Paleozoic rocks are faulted against pre-Cambrian rocks.

Lithology

The Kittatinny limestone at Clinton is generally thick bedded and dolomitic; most of it is light gray, though blue limestone and thin layers of black siliceous and feldspathic limestone are also present. Some beds weather buff. Chert is sparsely scattered through much of the rock. In some places it is in brecciated zones and appears to be secondary. At such places the chert may be either the matrix between fragments of limestone or unoriented fragments within a matrix of limestone. At other places, particularly the outcrops about 150 feet west of Demotte's garden (fig. 2), the chert is conformable to the bedding of the limestone; though in detail the chert contact (between chert and limestone) is irregular or botryoidal.

The Kittatinny limestone conformably overlies the Hardyston quartzite of Cambrian age and is unconformably overlain by the Jacksonburg limestone of Ordovician age. Martinsburg shale overlies the Jacksonburg limestone. None of these formations crop out in the mapped area (fig. 2). The Martinsburg, however, may possibly have a bearing on the origin of the uranium at Clinton.

Structure

Faults are regionally and locally the most significant structural features. The regional faults generally strike northeasterly (fig. 1). The area in the immediate vicinity of Clinton, however, is characterized by a more complex fault pattern that is probably the result both of pre-Triassic faulting and folding and of faulting during or later than Triassic time.

At Clinton the major structural feature is a fault zone about 15 feet wide; it strikes N. 30° E. and dips from 78° SE. to 40°NW. The best exposure of this zone is in the southern part of Mulligan quarry (fig. 2). Outcrops and radioactive anomalies show that the fault extends at least 700 feet. Houses and roads prevent determining how much farther the fault may extend.

This fault zone is probably the result of two movements in nearly opposite directions. The first movement caused brecciation that has since been tightly healed with dolomitic limestone and clay gouge; the north side of the fault moved down relative to the south side and the brecciated zone is about 15 feet wide. The later movement produced highly fractured rock loosely cemented by fault gouge in zones as much as 2 feet wide within the 15 foot brecciated zone. Evidence for the direction and relative time of these movements is: a) orientation by drag of a few large fragments of limestone in the breccia; b) the brecciated zone is not parallel to the highly fractured part of the fault; c) the brecciated zone is offset several feet on either side of a highly fractured part of the fault; d) it seems incongruous that such a tightly healed brecciated zone could still have open fractures that resulted from the same movement. The exposure at the south end of Mulligan quarry shows only one highly fractured zone about 2 feet wide. The same fault in the north part of Demotte's garden, however, shows two parallel highly fractured zones, each 1 to 2 feet wide, separated by a horse of tightly healed brecciated limestone. Highly polished slickensides indicate that the movement was oblique; lineation of the slickensides ranges from 5° NE. to 44° SE. The displacement is not known for either movement, but the net throw has raised the north side of the fault about 2 feet.

Many small faults with displacements of only a few inches are present south of the main fault zone; they range in strike length from several inches to several feet. A few small faults are present north of the fault. The north side of nearly every one of these small faults has moved up. About 1-1/2 miles northeast of the quarry two faults offset the Hardyston quartzite (fig. 1) in the same direction as fault movement in the quarry. The obvious similarity in direction of movement and strike suggests the faults may be related.

Mineralogy

Microscopic examination and chemical tests show that breccia (sample FK-129, table 1) from the fault zone at the south end of the quarry is chiefly dolomite. Fragments of gray dolomite range from about 1 millimeter to as much as 250 millimeters in length and are cemented with a white to yellow, clayey carbonate matrix. A thin section shows that a little secondary quartz and feldspar are also present in the matrix. The breccia is about 75 percent soluble in 2:1 hydrochloric acid.

A thin section of medium gray dolomitic rock (part of FK-128) a few inches above a black uraniferous layer cut by a small fault at the north end of the quarry shows about 40 percent feldspar, 30 percent quartz and chalcedony (?), and 30 percent dolomite. The dolomite occurs as very small (0.005 to 0.01 millimeter in cross section) rhombohedral and hexagonal forms. Some of the quartz appears to be detrital because the

Table 1.--Analyses of samples from Clinton, New Jersey 1/

Sample Number	Description	Type of sample and length	Location	Equivalent uranium (percent)	Uranium (percent)
FK3-51	Dark blue limestone and limestone breccia	Channel 2 ft.	2 ft. south of fault surface in hanging wall of fault zone at south end of Mulligan quarry	< 0.001	< 0.001
FK3-52	Fine limestone breccia with blue fragments in white matrix	Do.	0 to 2 ft. south of fault surface, in hanging wall of fault zone at south end of Mulligan quarry	< 0.001	< 0.001
FK-53	Limestone breccia	Channel, 2 ft	In highly sheared zone, which is 1.5 feet wide, of fault at south end of Mulligan quarry, 3 to 5 feet above floor of quarry	0.013	0.012
FK3-54	Limestone breccia	Channel, 2 ft.	In highly sheared zone, 2 feet wide, of fault at south end of Mulligan quarry, 0 to 2 ft. above floor of quarry	0.011	
FK3-55	Do.	Do.	0 to 1 ft. north of highly sheared part of fault zone at south end of Mulligan quarry, 4 ft. above floor of quarry	0.012	0.011

1/ All analyses by U. S. Geological Survey Trace Elements Laboratory

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Table 1.--Analyses of samples from Clinton, New Jersey--Continued.

Sample Number	Description	Type of sample and length	Location	Equivalent uranium (percent)	Uranium (percent)
FK3-56	Limestone breccia	Channel, 2 ft.	1 to 2 ft. north of highly sheared part of fault zone at south end of Mulligan quarry, 3 to 4 feet above floor of quarry	0.007	--
FK-57	Do.	Do.	2 to 4 ft. north of highly sheared part of fault zone at south end of Mulligan quarry, 4 to 5 ft. above floor of quarry	0.002	0.002
FK3-58	Clay and limestone breccia	Grab	5 ft. north of highly sheared part of fault zone at south end of Mulligan quarry; from gouge on surface of small slip.	0.035	--
FK3-59	Dense limestone breccia	Channel, 2 ft.	5 to 7 feet north of highly sheared part of fault zone at south end of Mulligan quarry	0.003	--
FK3-60	Limestone breccia and orange-yellow clay	Channel, 1 ft. by 2 inches.	At hanging wall contact of highly sheared part of fault zone at south end of Mulligan quarry	0.041	0.038
FK3-61	Orange-yellow clay	Selected	Do.	--	--

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Table 1.--Analyses of samples from Clinton, New Jersey--Continued

Sample Number	Description	Type of sample and length	Location	Equivalent uranium (percent)	Uranium (percent)
FK3-62	Limestone breccia	Selected	3 ft. north of highly sheared part of fault zone at south end of Mulligan quarry	--	--
FK3-63	Black limestone layer about 4 inches thick	Grab	8 ft. south of small fault at north end of Mulligan quarry	0.030	0.026
FK3-64	Black limestone layer about 10 inches below FK3-63	Do.	Do.	0.042	--
FK3-65	Intraformational conglomerate layer about 1 inch thick	Do.	3 to 5 ft. south of fault at north end of Mulligan quarry	0.074	0.069
FK3-66	Fault surface limey gouge material	Do.	Fault at north end of Mulligan quarry	0.012	--
FK3-67	Limey and clay gouge material, white and orange-yellow	Do.	From fault surfaces of fault at north end of Mulligan quarry	0.012	--
FK3-68	Clayey gouge and fine-grained breccia	Selected	Surface of fault in Demotte garden	--	--
FK3-69		Do.		--	--
FK3-70	Orange-pink semivitreous material on fault surface	Do.		--	--

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Table 1.--Analyses of samples from Clinton, New Jersey--Continued

Sample Number	Description	Type of sample and location	Location	Equivalent uranium (percent)	Uranium (percent)
FK3-71	Sheared hard blue limestone	Grab	35 ft. above quarry floor, in horse between 2 major fractures in fault zone in Demotte garden	0.005	0.005
FK3-72	Brecciated limestone	Do.	South side of fault zone in Demotte garden	0.018	0.018
FK3-73	Brecciated limestone with some clayey gouge	Do.	Southwestern end of fault zone in Demotte garden	0.009	--
FK3-74	Upper 6 inches of soil	Do.	About 100 feet west of western edge of northern part of Mulligan quarry	0.017	--
FK3-75	Do.	Do.	About 400 feet southwest of western edge of northern part of Mulligan quarry	0.009	0.007
FK3-76	Soil from 6 to 12 inches below the surface, immediately below FK3-75	Do.	Do.	0.011	0.008
FK3-88	Churn drill well cuttings	Do.	35 foot bailing from well 200 feet southwest of Demotte garden	.014	.014

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Table 1.--Analyses of samples from Clinton, New Jersey--Continued

Sample Number	Description	Type of sample and length	Location	Equivalent uranium (percent)	Uranium (percent)
FK3-89	Limestone breccia	Grab	25 feet east of well	.003	.003
FK3-94	Limestone, churn drill well cuttings	Do.	50 ft. bailing from well, 200 ft. southwest of Demotte garden	0.006	0.007
FK3-95	Limestone, churn drill well cuttings	Do.	60 foot bailing from well, 200 ft. southwest of Demotte garden	0.005	0.005
FK3-96	Limestone, churn drill well cuttings	Do.	75 foot bailing from well, 200 ft. southwest Demotte garden	0.016	0.017
FK-128	Black dolomite	Do.	2 to 5 ft. south of fault in northern part of quarry	.049	.046
FK-129	Gray dolomite breccia with coating of yellow-green mineral	Do.	Fault surface in northern part of Mulligan quarry	.008	.007
FK-132	Dolomite breccia	Do.	Fault zone in southern part of Mulligan quarry	.008	--

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grains are rounded; they are about 0.05 millimeter in cross section. Most of the quartz is secondary and and replaces dolomite or fills microfractures in the fine dolomite matrix. The quartz has sutured contacts, is intergrown with feldspar, and has inclusions of dolomite. Feldspar is much more abundant than cursory inspection of the thin section indicates. It ranges from 0.05 to 0.10 millimeter in cross section and has sutured contacts. Some of it has albite twinning, but much is not twinned. An X-ray powder pattern of sample FK-128 shows that the major constituent is albite. Hydrochloric acid diluted 2 to 1 dissolves 30 percent of the rock. A little euhedral pyrite and black opaque matter are also present.

Apatite is inferred to be the radioactive mineral in the fault zones; however, the evidence is indirect and inconclusive. Fluorescent bead tests of yellow-tan apatite (identified by X-ray) from fault surfaces show that it contains uranium. X-ray spectrometer and optical studies by Jerome Stone (U. S. Geol. Survey Trace Elements Laboratory) of selected samples (FK3-61, -68, -70) of the most radioactive material from several places in the fault zones show in addition to apatite, dolomite or carbonate material in each sample and montmorillonite in one.

URANIUM OCCURRENCES

Uranium occurs in three different environments in the Mulligan quarry area: a) fault zones with highly fractured dolomitic limestone and limestone breccia; b) two layers, each 4 inches thick, of feldspathic black dolomite overlain by about 4 feet of uraniferous gray feldspathic and siliceous dolomite; c) radioactive zones in a thin mantle of residual soil derived from limestone.

The most obvious and probably the most significant occurrences of uraniferous rocks are those in fault zones. With the exception of the zone exposed at the south end of Mulligan quarry, all the uranium-bearing faults are small and have displacements of a few inches along a single fracture. The radioactivity of a few of the zones is as much as 0.25 mr/hr. These zones are generally less than one foot wide and cannot be traced for more than 10 feet.

The largest fault zone in the area is radioactive everywhere it crops out and at many places where it is covered with soil. It has been traced from the south end of Mulligan quarry southwestward for about 700 feet to the backyards of several houses along U. S. Highway 22. The fault zone ranges from about 1 foot to 15 feet in width. Though it is radioactive throughout, at no place is the radioactivity greater than 0.4 mr/hr. Apatite, which occurs as thin powdery or glassy coatings on some of the fracture surfaces, and a small amount of clayey, slightly iron-stained gouge in the fault zone are the only radioactive minerals observed. Analyses of samples (FK3-51 to -62, table 1) from the fault zone show that the uranium content ranges from 0.000 to 0.038 percent.

A water well, being drilled at the time of this examination (1953), is located on the main fault zone (fig. 2). A gamma-ray logging probe was improvised and the well was tested for gamma-ray radioactivity. The well was drilled to a depth of 157 feet, but the longest cable available for the probe permitted testing only to a depth of 87 feet. Samples of cuttings from the 35, 50, 60, and 75 feet bailings were analyzed. Neither the testing nor analyses of samples indicate any high concentrations of uranium. The highest radioactivity measured in the well was 0.3 mr/hr; the sample (FK3-96) containing the most uranium was from 75 feet and assayed 0.017 percent uranium.

At the north end of Mulligan quarry parts of two layers of black dolomite, each about 4 inches thick, are radioactive. About 4 feet of overlying light gray dolomite is also a little radioactive. The black layers grade into the gray limestone; they apparently are a facies of a black shaly layer that crops out 100 feet to the northeast. The rock is radioactive, however, for only about 15 feet along strike to the southwest; farther along, the lithology is essentially the same but the rock is not radioactive. A small fault (fig. 2) with a few inches displacement is roughly the northeastern limit of the radioactive rock. The fault strikes about due west and is vertical. Its southwestern wall, which is the only side exposed, is radioactive. Part of the wall has a thin coating of white and orange-brown apatite similar to the fault surfaces at the south end of the quarry.

The third type of occurrence of radioactive rock is the zones of residual soil in the fields west of the quarry. The isorads in figure 2 show that the zones are elongated roughly parallel to strike of bedding. The highest intensity of radioactivity in these zones is 0.08 mr/hr. Analyses of samples (FK3-75, -76) indicate that the uranium is in secular equilibrium, therefore, it probably is residual, derived from weathering of the underlying limestone and is not very mobile. Only one outcrop (at strike and dip symbol on figure 2) is in the area of these zones, and it is not radioactive.

ORIGIN OF URANIUM

Two hypotheses are presented to explain the uranium deposits at Clinton: a) The deposits are supergene -- uranium has been derived from overlying slightly uraniferous sedimentary rocks and deposited in fault zones in the Kittatinny limestone; b) the deposits are telethermal.

Fault zones developed during Triassic and probably Paleozoic time may have served as channels for later percolating meteoric waters. Two formations that at one time overlaid the limestone are possible source rocks for the uranium. Geiger-counter tests at outcrops indicate that the Martinsburg shale contains about 0.003 percent equivalent uranium in the vicinity of Clinton as well as over large areas in New Jersey and Pennsylvania. The Lockatong formation of Triassic age may also have been the source of the uranium. It is not known to be uraniferous in the vicinity of Clinton, though no field tests have been made. About 15 miles, approximately along strike, to the southwest, however, several beds of black argillite in the Lockatong formation contain up to 0.05 percent uranium (McKeown and Choquette, in preparation). Uranium leached from one or both of these formations may have been deposited from meteoric waters by absorption on clay or phosphate minerals in the gouge of fault zones. Also, the alkaline conditions caused by the limestone may have further enhanced the deposition of uranium. The uraniferous black limestone at the northern part of Mulligan quarry may be the result of preferential absorption of uranium in the carbonaceous silty layers of the dolomite. It may be significant that the only black limestone layers found to be uraniferous are cut by a fault that contains uraniferous phosphatic material.

The uraniferous soil zones are probably the result of uranium being retained with clay derived from the dolomite. Though the shape of the radioactive zones outlined by isorads on figure 2 is partly dependent upon interpretation of the radioactivity grid survey, the alinement of the zones is distinct and nearly parallel to the strike of bedding. Both the alinement and shape may be functions of: 1) original distribution of uranium in the limestone; 2) strike and dip of bedding; 3) attitude of fracture or fault systems; 4) composition of the soil; and 5) topography.

Except for the layers of uraniferous black dolomite in the northern part of Mulligan quarry, all exposures of uraniferous rock indicate that the deposition of uranium is related to fractures or faults; the radioactive zones in the field are inferred to be related to uranium whose deposition was controlled by bedding plane fractures.

Secondary albite and quartz and the presence of albite in or near fault zones may possibly suggest hydrothermal activity. The paucity of elements such as copper, lead, zinc, and bismuth (table 2), which are common in hydrothermal deposits, and the lack of discrete uranium minerals are strong arguments against a hydrothermal source for the uranium.

RESERVES

The reserves of uraniferous rock in the vicinity of Mulligan quarry are moderately large but very low grade. The fault zone that extends southwestward for about 700 feet from the southern end of the Mulligan quarry is the only radioactive zone large enough and well enough known to justify estimation of reserves. Reserves of the uraniferous black feldspathic dolomite at the north end of Mulligan quarry are negligible.

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Table 2--Results of spectrographic analyses[1] of samples from Clinton, New Jersey[2]

Sample Number	X0. %	X. %	.X %	.0X %	.00X %	.000X %
FK3-60	Ca Mg	P Si Al	Na Fe	Sr Ti Y Zr Mn	B Ba Cr Ga Pb Yb Cu Sc V	------------
FK3-88	Ca Mg	Si Al Na	P Fe	Sr Ti Mn	Ba B Ga Y Zr Cu Pb V	Yb
FK3-89	Ca Mg	Si Na Al	Fe P	Sr Ti Mn	B Ga Ba Cu Y Zr Pb V	Yb
FK-129	Ca Mg	------	Al Si Na	Fe Mn	B Ti Ba Sn Cr Pb Y Zr V	Yb
FK-132	Ca Mg	Si	Al Na Fe P	Sr Mn Ti	Cu B Ni Ba Cr Y Pb Sn V	Yb

1/ Analyses by Katherine E. Valentine and Helen W. Worthing, U. S. Geological Survey

2/ See table 1 for descriptions of these samples.

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Though the radioactive soil zones in the fields several hundred feet west of the quarry contain a little uranium, the nature of the rock underlying these zones is not known. If the rock is uraniferous, the isorads on figure 2 suggest that the uraniferous zones are discontinuous and alined approximately parallel to the strike of the bedding. The real shape of the zones, however, may be quite unlike the areas outlined by the isorads because: a) the isorads are interpretive, and b) the uranium content of the soil may depend on drainage and composition of the soil as well as on the structure and lithology of the underlying rock. Because of these unknown factors and the fact that at no place, either outcrop or soil, in the Mulligan quarry area is the concentration of uranium close to ore grade, no estimates of reserves seem warranted for the radioactive zones in the fields.

Analyses of channel samples FK3-53, -54, -55, and -56 (table 1) show that outcrop of the fault zone at the end of Mulligan quarry contain an average of 0.010 percent uranium over a width of 5.5 feet. Grab samples FK3-71, -72, -73, -94 and -96 and radioactivity measurements made at outcrops of the fault zone indicate that 0.010 percent uranium is a reasonable estimate of the average grade of a 5.5 foot width of the fault zone between the quarry and the well. Southwest of the well the fault zone probably pinches to less than 5 feet in a short distance; no data are available on the uranium content of the rock. The limits, therefore, of inferred reserves of uraniferous rock are: from the south end of Mulligan quarry to the well (360 feet, strike length); a width of 5.5 feet; and an assumed dip length of half of the strike length, or 180 feet. By calculation this is about 360,000 cubic feet or, using a factor of 11 cubic feet to the ton, about 30,000 tons of brecciated dolomite limestone containing 0.010 percent uranium.

CONCLUSIONS

Detailed sampling, mapping, and testing of the Mulligan quarry area indicate that no currently economic deposits of uranium are present; the grade of the uraniferous rock is too low. Further, interpretation of the geology does not indicate any good prospects of finding higher grade deposits at Clinton. Prospecting along fault zones in the area may result in the discovery of similar deposits. The Triassic rocks south of Clinton may possibly contain uraniferous black argillite.

UNPUBLISHED REPORTS

King, R. U., and Wilmarth, V. R., 1950, A radioactive limestone at the Mulligan quarry near Clinton, Hunterdon County, New Jersey: File Report, U. S. Geological Survey.

McKeown, F. A., and Klemic, Harry, 1953, Reconnaissance for radioactive materials in northeastern United States during 1952: U. S. Geol. Survey Trace Elements Inv. Rept. 317.

McKeown, F. A., and Choquette, P. W., in preparation, Uranium in the Triassic rocks of Hunterdon County, N. J. and Bucks County, Pa.: U. S. Geol. Survey Trace Elements Inv. Rept.

Stewart, R. H., 1951, Radiometric reconnaissance examination in southeastern Pennsylvania and western New Jersey: U. S. Geol. Survey Trace Elements Memo. Rept. 255.

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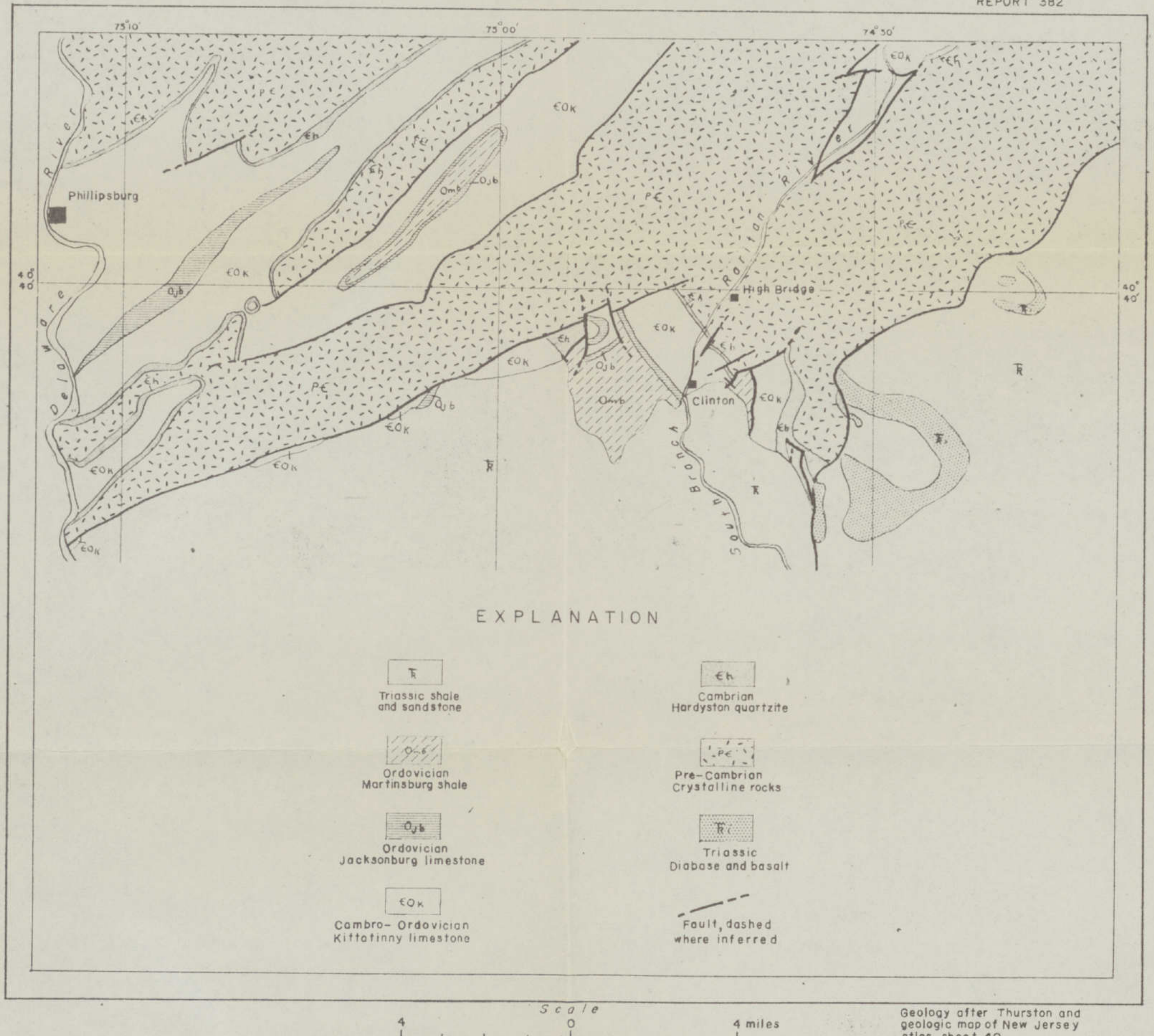

Geology after Thurston and geologic map of New Jersey atlas sheet 40

FIGURE 1 - MAP SHOWING GEOLOGY OF PART OF HUNTERDON COUNTY, N. J.

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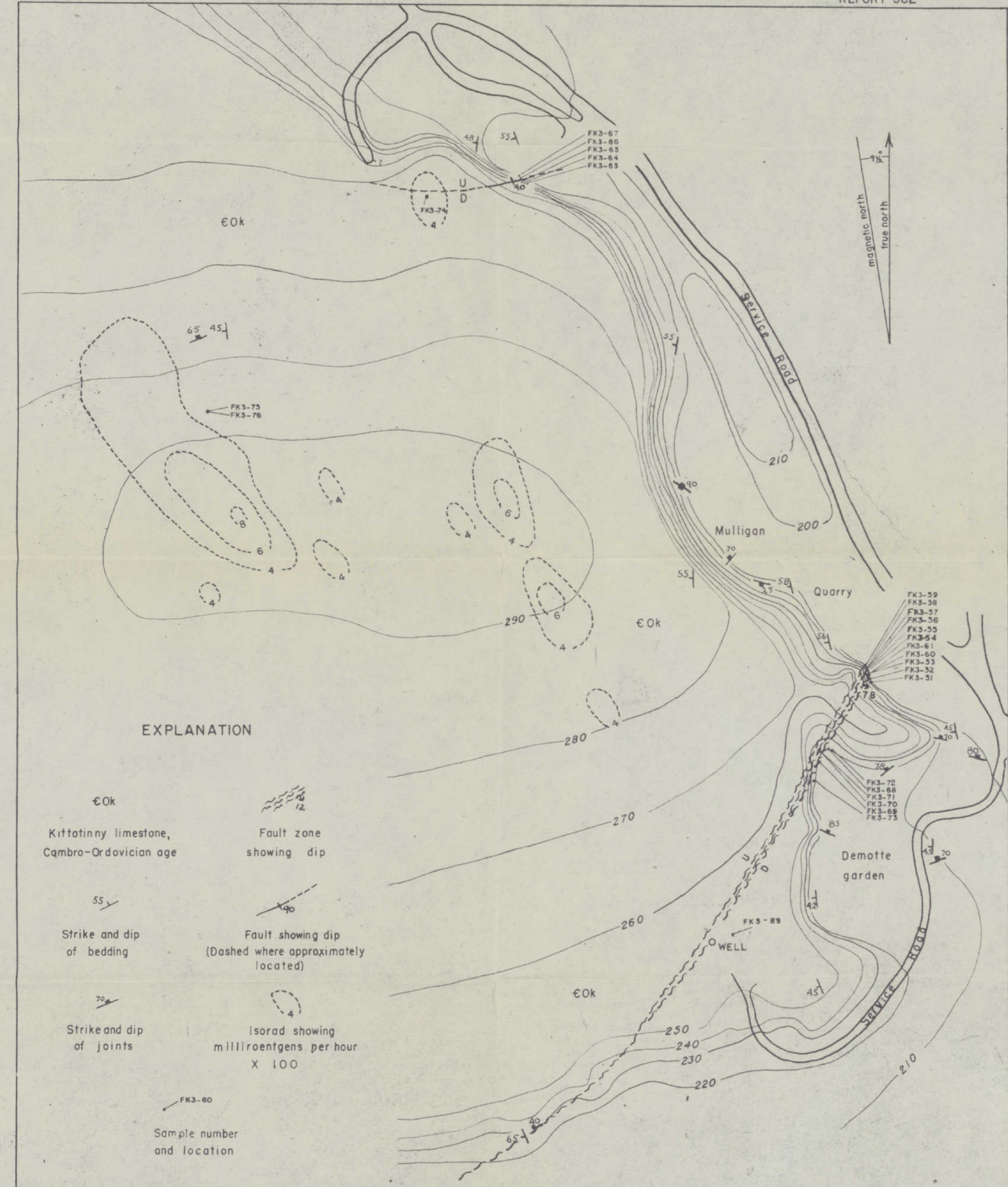
REPORT 382



Geology and topography by
F.A.McKeown and P.W. Choquette

0 100 200 300 feet
Contour interval 10 feet
Datum is mean sea level

FIGURE 2- GEOLOGIC MAP SHOWING URANIUM OCCURRENCES IN THE VICINITY OF MULLIGAN QUARRY AT CLINTON, NEW JERSEY

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