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RECONNAISSANCE FOR RADIOACTIVE MATERIALS IN NORTHEASTERN UNITED STATES DURING 1952

By
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This report is preliminary and has not been edited or reviewed for conformity with U. S. Geological Survey standards and nomenclature.

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By Francis A. McKeown and Harry Klemic

ABSTRACT

Reconnaissance for radioactive materials was made in parts of Maine, New York, New Jersey, and Pennsylvania. The primary objective was to examine the iron ore deposits and associated rocks in the Adirondack Mountains of New York and the Highlands of New Jersey. In addition, several deposits known or reported to contain radioactive minerals were examined to delimit their extent. Most of the deposits examined are not significant as possible sources of radioactive elements and the data pertaining to them are summarized in table form.

Deposits that do warrant more description than can be given in table form are: Benson Mines, St. Lawrence County, N. Y.; Rutgers mine, Clinton County, N. Y.; Mineville Mines, Essex County, N. Y.; Canfield phosphate mine, Morris County, N. J.; Mulligan quarry, Hunterdon County, N. J.; and the Chestnut Hill-Marble Mountain area, Pennsylvania and New Jersey.

The Old Bed in the Mineville district is the only deposit that may be economically significant. Apatite from Old Bed ore contains as much as 4.9 percent total rare earth, 0.04 percent thorium, and 0.018 percent uranium.

Magnetite ore at the Rutgers mine contains radioactive zircon and apatite. Radioactivity measurements of outcrops and dump material show that the ore contains from 0.005 to 0.010 percent equivalent uranium. One sample of lean magnetite ore contains 0.006 percent equivalent uranium.

The Canfield phosphate mine was originally opened as a magnetite mine but contains about 35 percent of apatite. Monazite is also present in the ore. The apatite and monazite are radioactive. The uranium and thorium content of the deposit is too low to merit further study at the present time.

Garnet-rich zones in the Benson Mines magnetite deposit contain as much as 0.017 percent equivalent uranium. Most of the rock and ore, however, contains about 0.005 percent equivalent uranium. Available data indicate that the garnet-rich zones are enriched in radioactive allanite.

A shear zone in the Kittatinny limestone of Cambrian age at the Mulligan quarry contains uraniferous material. Radioactivity anomalies elsewhere in the quarry and in adjacent fields indicate that there may be other uraniferous shear zones. Assays of samples and measurements of outcrop radioactivity indicate that the uranium content of these zones is low; samples contain from 0.008 to 0.068 percent equivalent uranium. The anomalies, however, may indicate greater concentrations of uranium below surficial leached zones.

The Chestnut Hill-Marble Mountain area contains radioactivity anomalies for about 2 miles along the strike of the contact of pre-Cambrian Pickering gneiss and Franklin limestone formations. In places this contact is injected with pegmatite, which probably was the source of the radioelements. The most favorable area for further study is at Marble Mountain, where a nearly continuous anomaly extends for about 1500 feet. Samples from part of this area contain as much as 0.044 percent equivalent uranium and 0.005 percent uranium. Radioactive hematite and florencite (?), in which thorium may have substituted for cerium, are the only radioactive minerals observed in the Marble Mountain area.

INTRODUCTION

A reconnaissance for radioactive materials was conducted in parts of Maine, New York, New Jersey, and Pennsylvania (figs.1,3,4,5,7) from July 19 to October 9, 1952, on behalf of the Division of Raw Materials of the Atomic Energy Commission.

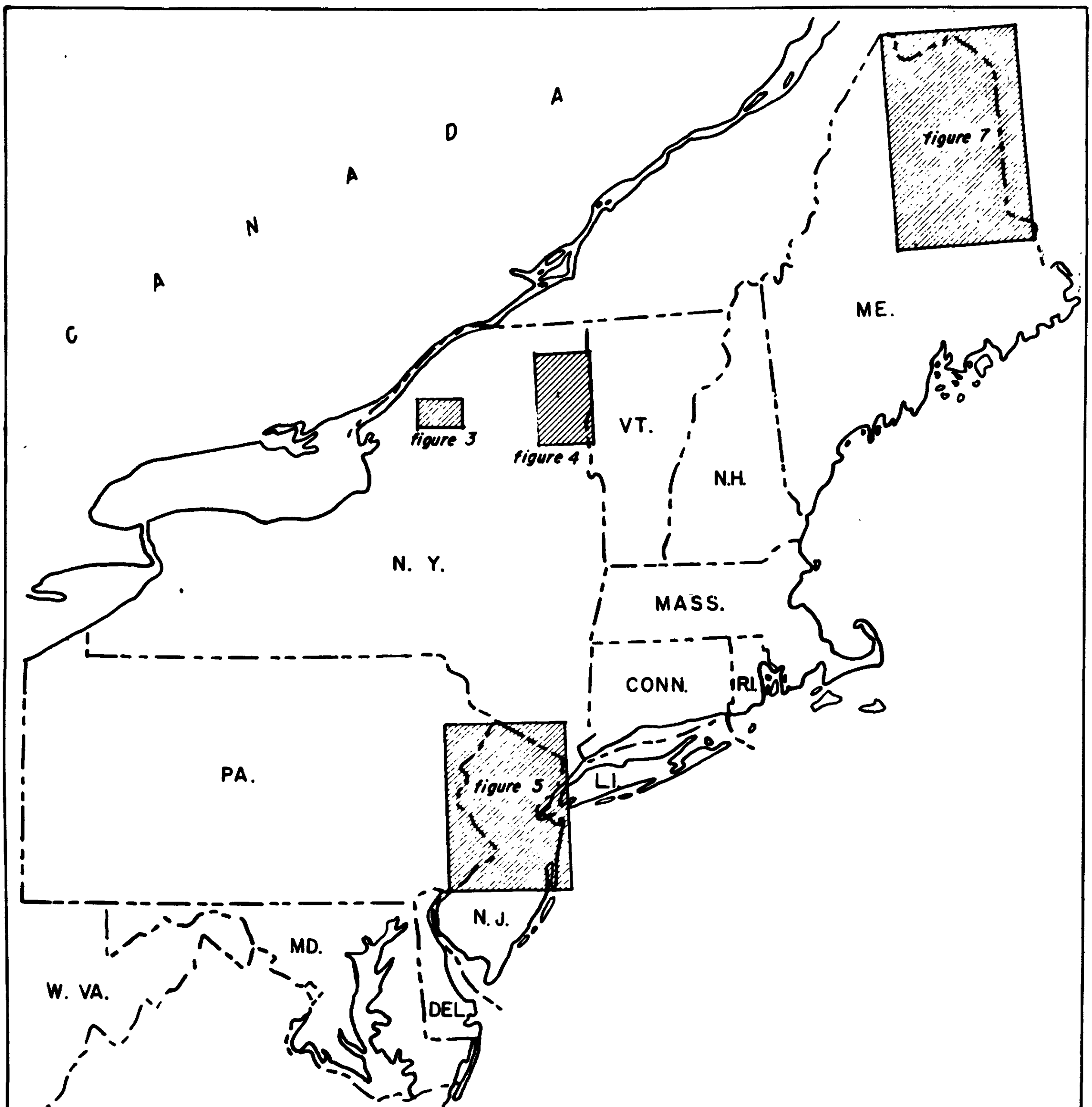

Fig. 1—Index map of northeastern U. S.

Although many types of mineral deposits were examined, most of the field work was devoted to examining iron ore deposits and associated rocks in the Adirondack Mountains of New York and in the Highlands of New Jersey. This study was made in order to see whether or not uranium is associated with titanium in these deposits as it is in the Tete district, Mozambique, Africa and at Olary, South Australia (Davidson and Bennett, 1950). Uranium at these foreign districts occurs in davidite, in skarn near the contacts of gabbro with limestone. Similar geologic settings are found at or near some of the magnetite deposits in northeastern United States.

Several other types of deposits also were examined. Because of the occurrence of pitchblende in a lead-zinc deposit in volcanic rock of Devonian(?) age near Cross Point, Quebec, two weeks were spent in northern Maine searching for a similar suite of minerals or geologic setting. Inasmuch as a systematic reconnaissance of northern Maine was not feasible, most of the time was spent making contacts with local inhabitants who may have had an interest in minerals or rocks and who could serve as guides to mineral deposits unreported in the literature.

Other localities such as the Annandale graphite mine 3 miles northeast of Clinton, N. J., and the Katahdin pyrrhotite deposit at Katahdin Iron Works, Maine were examined because they were along the route to deposits scheduled for examination. Several deposits known to contain radioactive minerals were examined or reexamined in order to obtain detailed information on their extent. These deposits are at Easton, Pa., Marble Mountain, Clinton, and Edison quarry, New Jersey.

All the mineral deposits examined by the writers and described in tables 1, 2, 3, and 4 have been known for many years. Most of them, however, had not been examined for anomalous radioactivity until mid 1952. Most of them had been explored by prospect pits or short adits and shafts; a few had extensive workings. The most recent work at most of the deposits was done 50 years ago; they are commonly overgrown or caved. Most of the deposits examined are neither significant as potential sources of uranium or thorium nor of scientific value. Data on the deposits are summarized in table form. The deposits described in each table are located on separate index maps. Figure 1 shows the areas covered by these index maps. Deposits that do contain material of economic or scientific interest are discussed in separate sections in more detail.

Acknowledgment

Ned E. Nelson of the Geological Survey was with the field party for several days in Maine and guided the writers to the lead-zinc-pitchblende deposit on the Busteed property at Cross Point, Quebec. He first discovered that the lead-zinc ore at this locality contained uranium and suggested that geologically similar areas in northeastern United States ought to be examined for radioactive minerals. John H. Eric, also of the Geological Survey, assisted the writers for 3 weeks during August, while they were working in the vicinity of Benson Mines and the Mineville district, New York.

Thanks are expressed to Harry Thwaites of Houlton, Maine, for guiding the party to the various mineral deposits near Houlton.

Geologists, mine managers, and other personnel of the Republic Steel Corp., Jones and Laughlin Steel Corp., Alan Wood Steel Co., Mt. Hope mine, Richard mine, and the Ringwood mine and Charles Dyson, C. K. Cabeen, and Arthur Montgomery of Lafayette College, Easton, Pa. are thanked for their aid.

MEASUREMENTS OF RADIOACTIVITY

All measurements of radioactivity at the outcrop were made with portable survey meters of the Geiger counter type, the gamma response of which was calibrated in milliroentgens per hour (mr/hr) by comparison with a standard radium source. Radioactivity measurements at the outcrop made during this survey may thus be compared to measurements of other surveys with similarly calibrated Geiger counters. The radioactivity of samples was measured with laboratory equipment[1/], the response of which was calibrated in percent equivalent uranium (% eU) by comparison with a standard sample containing a known amount of uranium in equilibrium with its daughter products.

1/ U. S. Geol. Survey Trace Elements Laboratory.

The values for the radioactivity measurements of outcrops expressed in mr/hr and the laboratory analyses of corresponding samples expressed in percent equivalent uranium are plotted in figure 2. As determined by a least squares analysis of the data, the equation of the curve that fits the points plotted on figure 2 is $\% \text{ eU} = 0.121 \text{ mr/hr} - 0.0036$. The coefficient of correlation for these data is 0.73, where 1.0 is perfect correlation. The curve (fig. 2) can be used to interpret outcrop measurements made with portable survey meters of Geiger counter type, calibrated in mr/hr, in terms of the equivalent uranium content of the rock.

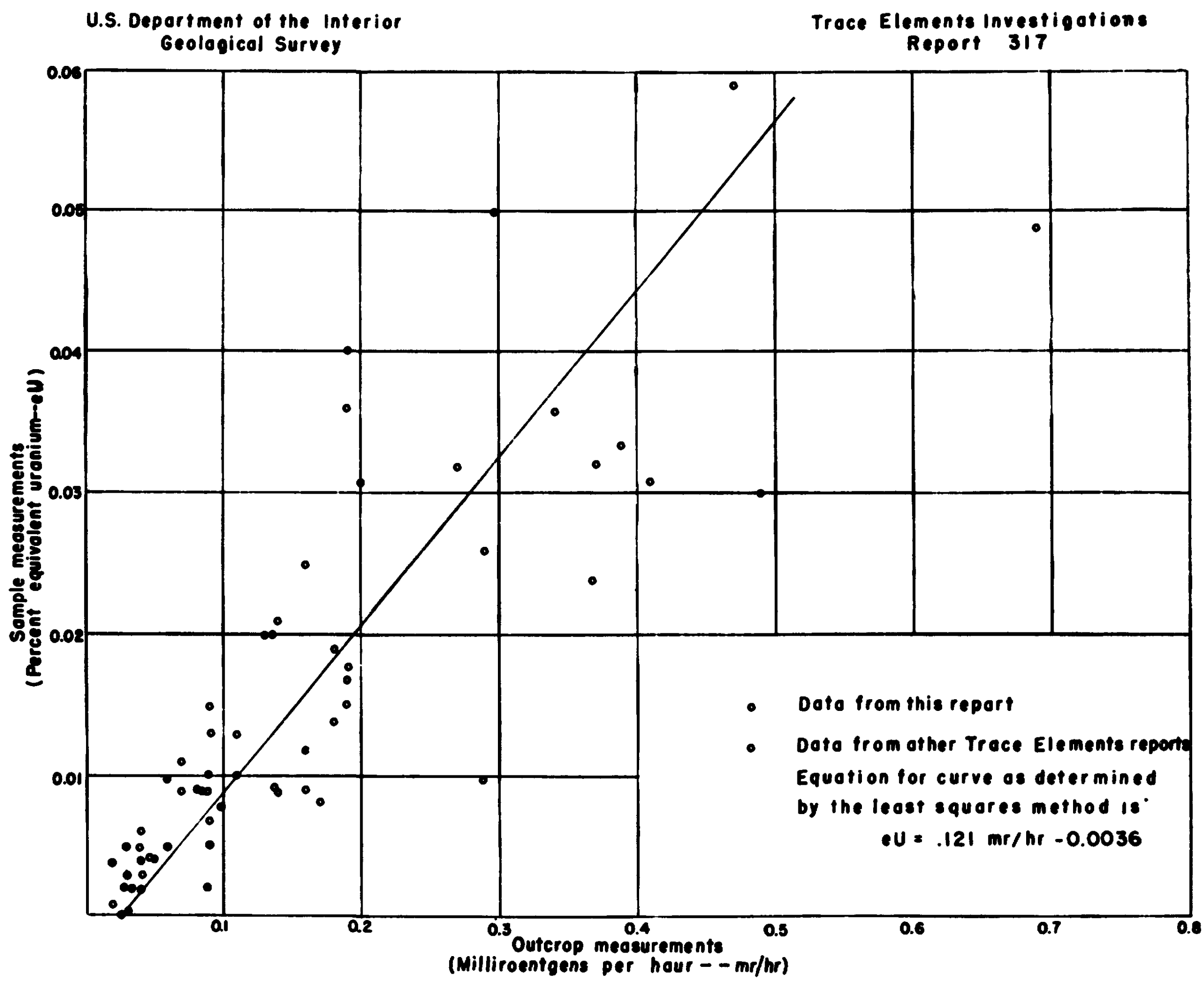

Fig. 2—Scatter diagram showing relation between outcrop and corresponding sample measurements of radioactivity.

GEOLOGY AND RADIOACTIVITY OF PRINCIPAL DEPOSITS

Benson Mines, St. Lawrence County, New York

The magnetite deposit at Benson Mines, 2 miles east of Star Lake, along New York Highway 3 (fig.3), is currently being operated by the Jones and Laughlin Steel Corp.

The ore is a replacement body of magnetite and hematite in microcline granite gneiss (Leonard, 1952, p. 89). Martite is also present as pseudomorphs after magnetite and, rarely, sulfide minerals. Like other magnetite ore bodies in granite gneiss in the Adirondack magnetite districts, the Benson ore body is large but relatively low in grade, averaging about 25 percent Fe. According to Leonard (1952, p. 92), the preferred host rocks of the granite gneiss ore are the biotite and sillimanite facies. Locally a pyroxenite facies also serves as host for some ore.

Various parts of the open cut were examined for radioactive minerals, including the northwestern part where torbernite in pegmatite has been reported. The outcrop of pegmatite had been stripped away, but several pieces of it in the waste rock contained allanite. The most radioactive parts of the ore body are locally called the "disseminated garnet zone" and the "blotchy garnet zone".

One sample (FK-59) of magnetite ore with garnet, feldspar, quartz, and allanite contains 0.017 percent equivalent uranium. Field tests and analysis for radioactivity of other samples (FK-60, -61, -63, -65, -66, -67, and 68) indicate, however, that most of the rock and ore contains from 0.002 to 0.006 percent equivalent uranium and averages about 0.005 percent equivalent uranium.

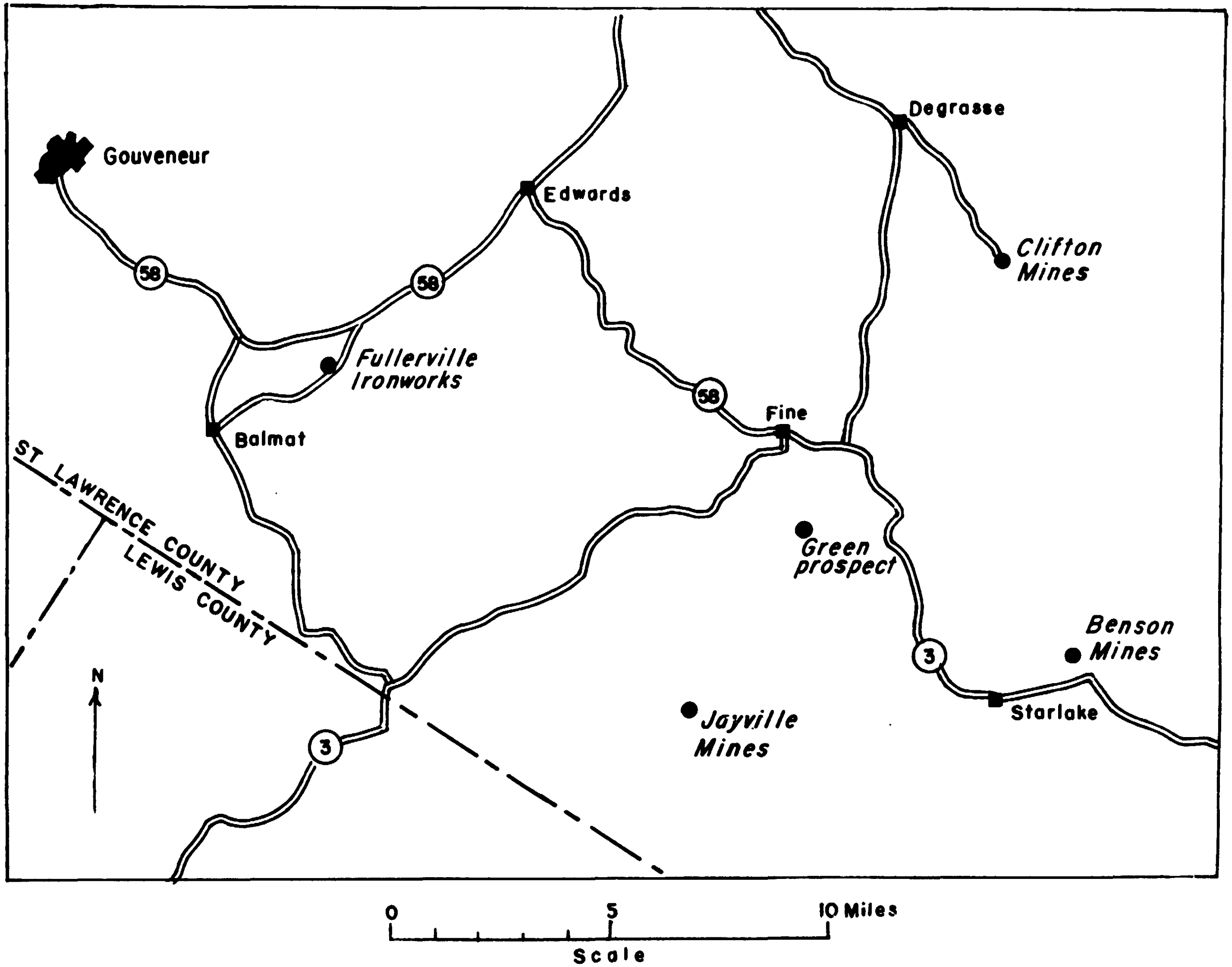

Fig. 3—Index map showing location of deposits examined in St. Lawrence County New York.

Rutgers mine, Clinton County, New York

The Rutgers mine, about 5 miles north of Ausable Forks (fig. 4), is the only mine examined of a group of 3 mines known as the La Vake-Rutger-Hogback mines. The workings are flooded, and past production is unknown. The dumps near the mine are estimated to contain about 300 tons of magnetite sub-ore.

Postel (1952, p. 58) states: "The Rutgers ore occurs in a pink syenite gneiss and plagioclase syenite gneiss of the Lyon Mountain granite gneiss containing numerous schlieren of pyroxene skarn."

Radioactivity measurements of outcrops and dump material show that the magnetite ore contains from 0.005 to 0.010 percent equivalent uranium. The syenite gneiss and pods and the schlieren of skarn in the gneiss contain less than 0.002 percent equivalent uranium. A sample (FR-51) of lean magnetite ore contains 0.006 percent equivalent uranium.

Mineralogic study of the ore shows that the radioactive minerals are zircon and apatite. Most of the ore and sub-ore on the dump is slightly radioactive. It is inferred that the radioactive elements are disseminated through the magnetite ore body and are not concentrated locally. The mineralogy, equivalent uranium content, and geology of this deposit are similar to the Old Bed at Mineville, N. Y. Inaccessibility of the workings and the scarcity of outcrops of ore make further study of the thorium and rare earth content of this deposit difficult and unwarranted, at least until the Mineville occurrence has been studied and an evaluation made of these types of deposits.

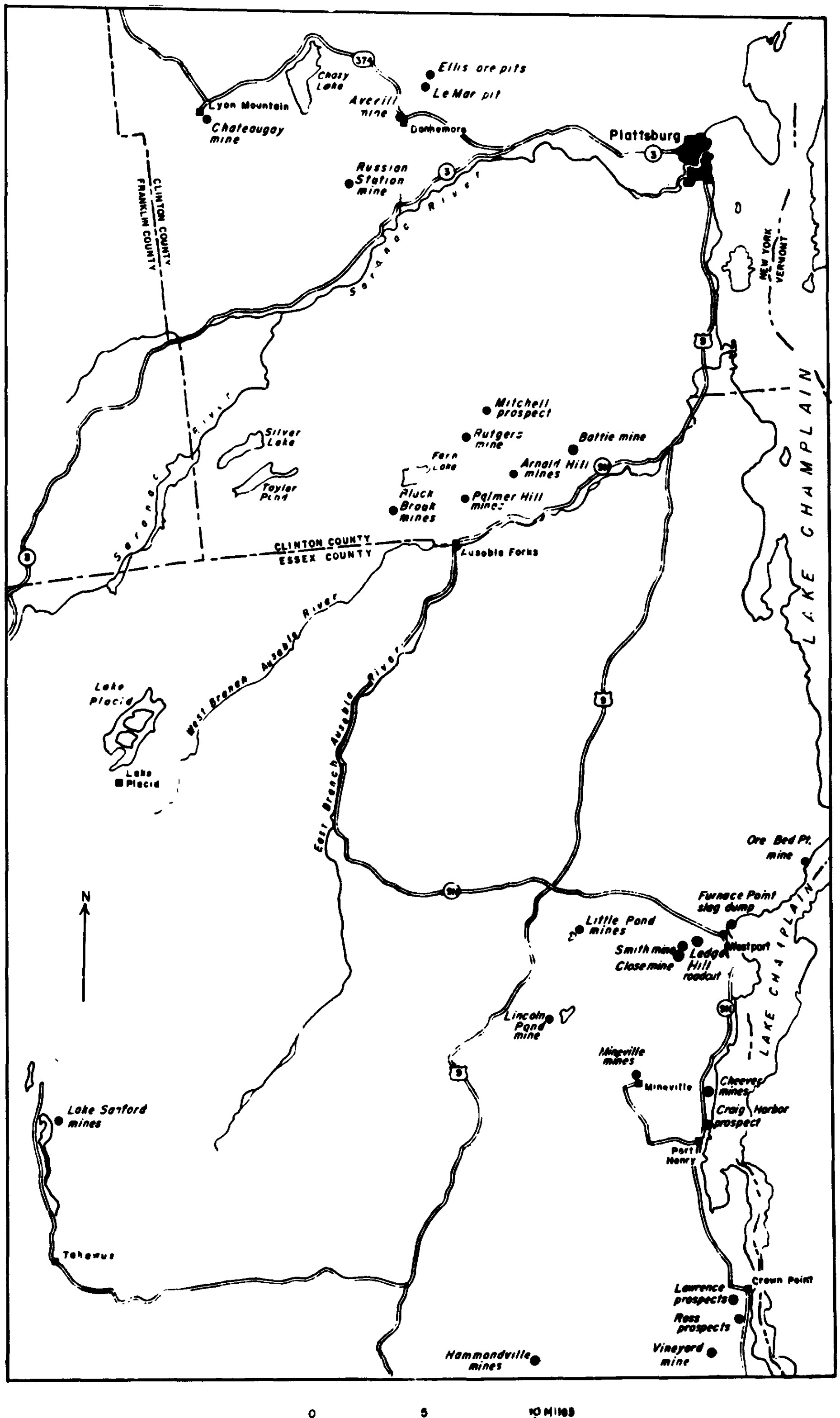

Fig. 4—Index map showing location of deposits examined in northeastern New York.

Mineville district, Essex County, New York

The mines in this district are all located in or near the village of Mineville (fig.4). They have been some of the richest and most productive magnetite mines in New York, and have been worked intermittently since about 1785. At present (1952) Republic Steel Corporation is mining three of the ore deposits: The Old Bed, the Harmony bed, and the Fisher Hill deposit. The Old Bed is part of the Mineville group of ore beds (Kemp, 1908, p. 72) located in the village of Mineville. The Harmony bed is about half a mile south of Mineville and the Fisher Hill deposit is about 2 miles north of Mineville. Another important group of mines is on Barton Hill, 1 mile northwest of Mineville; these are no longer worked. The Old Bed is of particular interest because apatite in it contains an unusually large percentage of thorium and rare-earth elements. A little uranium is also present in the apatite.

The 1952 discovery of thorium and rare-earths in the Old Bed ore answers the question of the source of these same elements found in slag at the Old Colburn furnace, 2½ miles south of Mineville, and the radioactivity anomalies detected in the vicinity of Mineville. These anomalies were first detected by traversing the roads in the Mineville district with carborne Geiger counter equipment during the summer of 1949 (Narten and McKeown, 1952).

According to Kemp (1908, p. 72) the Mineville group consists essentially of three separate, faulted parts of one complexly folded ore bed. The separate parts, though they may consist of more than one body of ore, are known as the Miller, Old Bed, and "21"-Bonanza-Joker ore bodies.

They occur as layers conformable to the foliation of enclosing syenite and gneiss and have been mined 7,000 feet down the dip (Linney, 1943, p. 489). The foliation strikes about N. 30° E. and pitches to the south. Because of the complex folding, the thickness of the ore bodies ranges from several feet to as much as 200 feet. The ore is massive or granular and ranges from 35 percent iron to almost pure magnetite (60 to 70 percent iron).

The gangue consists of hornblende, augite, quartz, feldspar, and apatite. Apatite is present in the very rich as well as the lean ore--the Old Bed is the richest ore body in the Mineville group and also contains the highest percentage of phosphorous (1 to 1¼ percent).

Syenite composed of microperthite, green augite, hornblende, and magnetite underlies the Mineville group of ore bodies. A gneiss, known as the "21" gneiss forms the hanging wall, and is generally composed of microperthite, quartz, magnetite, and a few dark silicates. The transition between the "21" gneiss and magnetite ore is sharp.

Apatite that occurs disseminated and in thin seams in the magnetite ore is radioactive. Microscopic examination shows that although it is transparent, it is coated with specks of hematite. X-ray diffraction patterns of handpicked grains (FK-73AA) show the mineral to be fluorapatite. Spectrographic analysis shows: Over 10 percent Ca, P; 1-10 percent Si, La, Ce; 0.1-1.0 percent Nd, Y, Th, Gd, Ba, Al, As, Fe, Mg, Dy, Pr; 0.01-0.1 percent Er, Yb, Sr, Sm, B, Mn, Cd, Co, Ho, Lu, Tm, Eu, Pb; 0.001-0.01 percent Ni, Sc, Ti, V, Ba; 0.0001-0.001 percent Cu, Cr, Be. By chemical analysis this sample contains 0.018 percent U, 0.04 percent Th, and 4.9 percent total rare earths.

The degree of radioactivity of various samples of ore, rock, concentrates, and tailings seems to be a function of the amount, as estimated visually, of red or flesh-colored apatite present in the sample. This feature is best illustrated by a comparison of radioactivity measurements made at the original tailings pile formerly processed to obtain apatite as a fertilizer with the reworked tailings from this process. The radioactivity of the original tailings ranges from 0.15 to 0.20 mr/hr and averages about 0.15 mr/hr; a sample (FK-73A) representative of material of average radioactivity contains 0.009 percent equivalent uranium. The radioactivity of the reworked tailings from which apatite has been removed averages 0.04 mr/hr; a representative sample (FK-72) contains 0.002 percent equivalent uranium. Testing of the tailings pile near the Harmony magnetic cobbing mill showed that parts of it average 0.1 mr/hr and contain 0.008 percent equivalent uranium (sample FK-77). These tailings are from both the Harmony and Old Bed, and the less radioactive parts of the tailings pile probably contain rock from the Harmony bed. The tailings pile at the No. 7 mill averages 0.04 mr/hr and a sample (FK-79) of it contains 0.004 percent equivalent uranium. This tailings pile is made up of rock from the Fischer Hill deposit, Harmony bed, and Old Bed, and its low equivalent uranium content is probably the result of the diluent effect of the Fischer Hill and Harmony rock on the radioactive Old Bed tailings.

The available data indicate that apatite in the Old Bed ore contains a higher percentage of rare earths and thorium than has previously been reported in apatite. The magnetite deposits at Mineville are analogous to the Kiruna type (Geijer, 1931, p. 14) of iron ores found in Sweden, Norway, Russia, Mexico, and Chile. From the Kirunavaara deposit in Sweden apatite

(96.67% pure) is reported to contain 0.88 percent cerium earth (Geijer, 1931, p. 7). Apatite (87.86 percent pure) from the Rektor ore body at Luossavaara contains 0.99 percent of the cerium group of rare earths and 0.05 percent yttria earths. As rare-earths are commonly associated with thorium and uranium, radioactivity measurements may be an expeditious means of estimating the rare-earth as well as radioelement content of apatite-rich material. Several other apatite-rich magnetite ore deposits were examined and sampled during the course of this reconnaissance, but Mineville ore is the most radioactive; and as the mines are in operation, the geologic and economic significance of such deposits can best be studied there.

Canfield phosphate mine, Morris County, New Jersey

The Canfield phosphate mine is located about 2 miles west of Dover, Morris County, N. J. (fig. 5). The mine was originally explored for magnetite, but the extremely high apatite content (about 35 percent) made the ore worthless for smelting for iron. According to Bayley (1910, p. 381) the ore body is 8 feet wide and dips 65° to the southeast; it was explored by two shafts, one of which was 40 feet deep. The workings are now completely caved and the area grown over with brush and trees.

The ore is a granular aggregate of magnetite and greenish-gray apatite. Quartz, feldspar, and biotite are minor constituents.

Radioactivity examination of the dump rock around the caved shafts showed the rock with the highest apatite content to be also the most radioactive. Laboratory examination shows that apatite and monazite are the radioactive minerals. Though monazite is several times as radioactive as apatite, very little of it is present in the rock. Thus apatite is the preponderant radioactive mineral. The uranium and thorium content of this deposit is too low to merit further study.

Mulligan quarry, Hunterdon County, New Jersey

Mulligan quarry owned by Michael C. Mulligan of Clinton, N. J., is located on the west bank of the Raritan River at Clinton, (fig. 5). The occurrence of radioactive rock here first became known when Mr. Thomas L. Eak of Avenel, N. J., submitted a sample of uraniferous limestone to the Geological Survey. On November 20, 1950, R. U. King and V. R. Wilmarth of the Survey examined the quarry for anomalous radioactivity. Part of their results are included in this report. On September 10, 1952, the authors visited the quarry and made a radioactivity survey of much of the area around as well as in the quarry. Radioactivity anomalies were found in an adjacent abandoned quarry in back of the Clinton House and in fields about 1,500 feet northwest of Mulligan quarry.

Mulligan quarry is about 600 feet long. At the time of the writers' visit only a few tons of limestone per week to supply local needs were being taken out of the middle of the southern part of the quarry. The abandoned quarry is about 300 feet long. Both quarries have been cut about 50 feet into a hill about 50 feet high underlain by limestone.

The quarry is in Kittatinny limestone of Cambrian age. The limestone is thick-bedded, predominantly light gray in color, strikes N. 5° W. and dips from 45° to 60° SW. In places it contains dark gray to black layers of limestone and chert. At the southern end of Mulligan quarry a shear zone, about 15 feet wide, strikes N. 25° E. and dips about 85° NW. It can be traced for about 500 feet southwest into the abandoned quarry, though there is less evidence of shearing to the southwest. The zone is made up of shears of two ages. A 2- to 3-foot shear within the 15 feet consists of highly fractured and crushed limestone and resulted from the most recent movement of the rock. The remainder of the 15 foot zone is a limestone breccia that has been cemented with the same limestone. It also has many fractures but they are probably related to the most recent shear.

The shear zone is radioactive in varying degrees as far as it can be traced. In general, however, the radioactivity decreases to the southwest. A sample (FK-132) chipped from a 2- by 6-foot area of the most sheared part assayed 0.008 percent equivalent uranium. Geiger counter measurements at the outcrop indicate that this sample is not representative; the assay is too low. The sample submitted to the Survey by Mr. Eak presumably came from this zone and assayed 0.068 percent uranium.

A yellowish-tan earthy material from the shear zone has been identified as apatite by X-ray. Fluorescent bead tests showed that the material contains uranium. The most radioactive part of the limestone is at the north end of the quarry, about 500 feet north of the shear zone. At this place a 4-inch layer of black limestone conformable to bedding measured 0.7 mr/hr. A sample (FK-128) of this limestone assayed 0.046 percent uranium. About 5 feet below the black layer, parts of a vertical joint surface are coated with a yellow-green mineral. The surface is radioactive and a sample (FK-129) taken from it assayed 0.007 percent uranium. The yellowish-green mineral has not been identified.

At several places in a pasture about 1,500 feet northwest of the Mulligan quarry, areas as much as 100 feet square measure from 0.05 to

0.20 mr/hr. There is no outcrop at these places. Though they are not on strike with the shear zone exposed in the quarry, the inference is that other radioactive shear zones may exist beneath the soil. Because uranium compounds leach readily, and the uranium is easily transported, the anomalies detected on the surface may possibly reflect greater concentrations of uranium at depth. One or two diamond core drill holes into the shear zone and a trench about 100 feet long and 4 feet deep bulldozed in the pasture would probably provide enough information to determine whether or not the deposit has any economic possibilities.

Chestnut Hill-Marble Mountain area

Numerous radioactivity anomalies and the occurrence of uranium- and thorium-bearing minerals on Chestnut Hill, Northampton County, Pa. and Marble Mountain, Warren County, N. J. (fig. 6) have stimulated interest in the possibility that these localities contain one or more deposits of economic value. Gehman suggested this possibility in 1936 (Gehman, 1936, p. 91). The anomalies occur discontinuously along the top of Chestnut Hill (fig. 6) from about 1.5 miles southwest of the Delaware River northeastward to Williams quarry on the southeast flank of the mountain, just north of the city limits of Easton. A rather continuous anomaly occurs for about 1,500 feet along the top of Marble Mountain (fig. 6), one mile north of Phillipsburg. In general, the anomalies range from about 0.04 to 0.08 mr/hr (where 0.02 mr/hr is background) and were detected with a 2- by 20-inch, gamma-sensitive Geiger counter. Except for Williams quarry, most of the anomalous areas on Chestnut Hill do not have outcrops and are less intense than on Marble Mountain. Though no real quantitative significance can be given to the value of an anomaly, measurements at large outcrops on Marble Mountain and relative paucity of megascopic radioactive minerals indicate that the anomalies are from large masses of weakly radioactive rock rather than small, high-grade concentrations whose radioactivity is reduced by soil or rock cover.

The geology of the Chestnut Hill-Marble Mountain area has been described by Bayley (1941). Peck (1904, p. 163-185) has described the talc deposits; Wherry (1918, p. 375-392) and Fraser (1939, p. 159-200) have made studies of some of the rocks in the area. In general the geology described below is from Bayley, with minor modification.

According to Bayley, Chestnut Hill and Marble Mountain are underlain by the Pickering gneiss and Franklin limestone of pre-Cambrian age. The Pickering gneiss probably contains 2 or 3 lithologic units that are mappable at least within the area shown on figure 6. Limestone and quartzite of Cambrian age are in fault contact with the pre-Cambrian rocks and crop out on the flanks of Chestnut Hill and Marble Mountain. A plug-like body of coarse-grained, white plagioclase-quartz granite intrudes the Franklin limestone a few hundred feet north of Williams quarry (fig. 6). This body is locally known as Anthony's Nose. Pegmatite, probably related to this granite and at places indistinguishable from it, cuts the Franklin limestone at the south end of Williams quarry.

The Pickering gneiss is made up of a variety of schists, gneisses, quartzite, and metamorphosed calcareous rocks. In the Easton area, this gneiss is usually a quartz-plagioclase gneiss that commonly contains sericite, hornblende, biotite, tourmaline, epidote, and magnetite. In places along the northwest side of Marble Mountain the gneiss is very rich in magnetite.

The Franklin limestone in the New Jersey Highlands is normally a white coarse-grained marble. In the Easton-Phillipsburg area, however, it is silicated primarily to talc, tremolite, and serpentine schists; asbestos and phlogopite are common, and pyrite and graphite are disseminated through some parts of the rock. Though Bayley has mapped them as part of the Pickering gneiss, the radioactive rocks on top of Marble Mountain as mapped in this report include part of the Franklin formation (fig. 6), because they have retained more of their sedimentary features than the Pickering gneiss usually does; they are more easily recognized as a sedimentary unit and may be interbedded with the limestone. These rocks on Marble Mountain are unlike any others found in the Easton-Phillipsburg area. They include; siliceous talc schist; hematitic quartzite, some of which is conglomeratic; and light tan, green, or purple, aphanitic, quartz sericite schist that looks very much like sheared rhyolite. All of the rocks have been subjected to intense shearing. Hematite occurs as thin layers, impregnations, and blebs in the quartzite. The Fulmer mine and numerous prospect pits in the hematitic quartzite on top of Marble Mountain are evidence of attempts to mine it as iron ore. Bayley (1941, p. 78) reports that over 1,000 tons of good ore was mined.

The radioactivity anomalies are within the Pickering gneiss and at or near the contact of the gneiss with the Franklin limestone. In some places this contact has been injected by pegmatite. This relationship is observed at the roadcut on top of Chestnut Hill along Pennsylvania State Highway 15, 1.5 miles northeast of Easton. All other anomalies along the top of Chestnut Hill are at places without outcrop. The pegmatite that cuts across the south part of Williams quarry is radioactive and contains thorite intimately associated with specular hematite. Thin coatings of autunite (?) on slickensided surfaces and on joints in serpentine were found at the northwest corner of the quarry. According to Prof. C. K. Cabeen of Lafayette College (oral communication) the thorium and uranium minerals for which the locality is well known were collected from the north face of the quarry. The zone containing such minerals was about 18 inches wide (Gehman, 1936, p. 90) and dipped steeply to the south parallel to the foliation of the serpentine. Quarrying operations have since removed the accessible parts of this zone. Part of it may still crop out but would be about 75 feet up the face of the quarry. Besides the thorite and autunite a zone along the west face of the quarry rich with phlogopite is radioactive; no radioactive minerals have been separated from this material.

An area approximately 1,500 feet long and as much as 500 feet wide on the top of Marble Mountain is underlain by radioactive rock. The radioactivity of some places within this area varies as much as tenfold. The most radioactive rock is the aphanitic, rhyolite-like-quartz sericite schist. Samples of this rock contain as much as 0.044 percent equivalent uranium (FK-166) and 0.005 percent uranium (FK-165). Talc schist float is also slightly radioactive; however, no outcrops of this rock have been observed. Hematitic quartzite is the least radioactive rock present on Marble Mountain.

A thorium-bearing phosphate mineral occurs in the sericite-quartz schist. An X-ray powder pattern of this mineral indicates that it may be florencite, $CeAl_3(PO_4)_2(OH_6)$. Spectrographic analysis, however, shows that thorium is the major element present. Other elements present are: minor, P, Si, Al, Fe; trace Ba, K, Sr, Y, Na, Ca. The mineral is pale chocolate color and usually occurs as irregular masses as much as half an inch long and a quarter of an inch thick. One specimen is euhedral, shows the rhombohedral habit of florencite, and measures about a quarter of an inch across the rhombohedral section. Insufficient data preclude determining whether this mineral is new, possibly a mixture of thorite and florencite, or fluorencite in which thorium has replaced cerium. The only other radioactive substance that could be isolated occurs as yellow to reddish brown smeared blebs about one-sixteenth of an inch wide and a quarter of an inch long. An X-ray powder pattern of this material showed it to be hematite.

The mineralogy and close spatial relationship of the abnormally radioactive rock in the Chestnut Hill-Marble Mountain area suggest that the source of the radioactive elements is pegmatite. A reasonable explanation is that mobile, aqueous end products of the granite underlying Anthony's Nose consolidated as pegmatite in some places and permeated the highly sheared and faulted zones of the pre-Cambrian rocks. The contact between such mechanically, physically, and chemically different rocks as the Franklin limestone and Pickering gneiss would probably afford the necessary set of conditions for the migration and precipitation of such end products.

Though the source of the radioactive elements may be pegmatite, structure and probably lithology are the controlling features of the concentration of the radioactive elements; radioactivity anomalies occur along strike of these features for a distance of more than 2 miles.

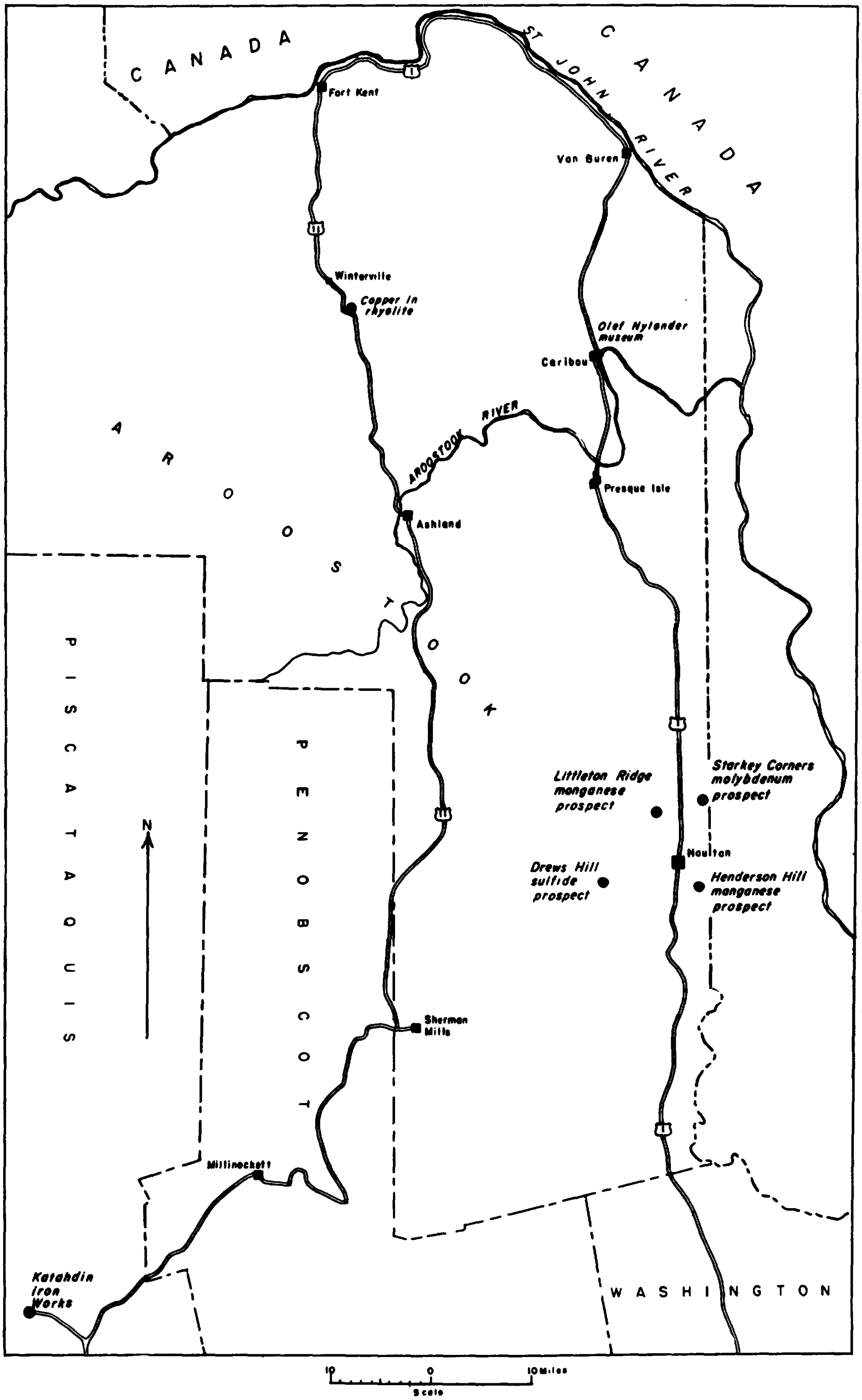

Fig. 7—Index map showing location of deposits examined in Maine.

Alphabetical index of deposits described in tables 1, 2, 3, and 4.

Alphabetical index of deposits described in tables 1, 2, 3, and 4. (Continued).

Alphabetical index of deposits described in tables 1, 2, 3, and 4. (continued)

Alphabetical index of deposits described in tables 1, 2, 3, and 4. (continued).

Alphabetical index of deposits described in tables 1, 2, 3, and 4. (continued).

Table 1.--Summary of data of deposits examined in Maine (fig. 7)

Name and location	Radioactivity (mr/hr or null if less than 0.03 mr/hr)	Sample number	Geology and remarks
Winterville roadcut Roadcut on State Highway 11 at top of hill, Winterville, Aroostook County	null	none	Rhyolite or andesite of Devonian (?) age; thin coatings of malachite on joint surfaces.
Starkey Corners molybdenum prospect 1 mile south of Starkey Corners, 8 miles north of Houlton, Aroostook County	do.	do.	Fractured and brecciated limestone of Silurian age near contact with granite. Limestone is mineralized with quartz, molybdenite, fluorite, copper and lead sulfides.
Drews Hill sulfide prospects 1/ Northeast side of Drews Hill, 7 miles west of Houlton, Aroostook County	do. do.	FK-27 FK-28	Quartz veins with pyrite, galena, sphalerite (?), and stibnite in contact metamorphic zone between granite and limestone of Silurian age.
Littleton Ridge manganese prospect 1/ About 5 miles north of Houlton, Aroostook County	do.	FK-29	Manganese- and iron-rich shales of Silurian age.
Henderson Hill manganese prospect 1/ On farm of Harry Thwaites, 2.5 miles southeast of Houlton, Aroostook County	do.	---	Do.
Katahdin Iron Works, Piscataquis County	---	---	Massive pyrrhotite body in gabbro and capped by a limonitic gossan.

1/ Miller, R. L., 1947

Table 2. —Summary of data of deposits examined in northeastern New York (fig. 4).

Name and location	Radioactivity (mr/hr or null if less than 0.03 mr/hr)	Sample number	Geology and remarks
Ellis Ore pits 2/ 1.0 mile northeast of Dannemora, Clinton County	1.0 max.	---	Magnetite ore in feldspar-pyroxene rock(granitized skarn?); amphibolite and plagioclase granite gneiss footwall; microcline granite gneiss hangingwall; Lyon Mountain granite gneiss formation, pre-Cambrian. Thorite and zircon are radioactive minerals present.
LeMar pit 2/ 1.0 mile northeast of Dannemora, Clinton County	null	---	Magnetite ore in granitized pyroxene amphibolite, coarse-grained to pegmatitic; Lyon Mountain granite gneiss formation, pre-Cambrian.
Averill mine 2/ Northwest side of village of Dannemora, Clinton County	do.	---	Magnetite ore in pyroxene granite gneiss, Lyon Mountain granite gneiss formation, pre-Cambrian. Thorite(?) in amphibolite of hangingwall.
Chateaugay mine 2/ Currently operated by Republic Steel Corporation at Lyon Mountain, Clinton County	--- ---	FK-37 FK-39	Magnetite replacement of pyroxene-contaminated microcline-microperthite granite gneiss and plagioclase granite gneiss; Lyon Mountain granite gneiss formation, pre-Cambrian.

2/ Postel, A. W., 1952

Table 2. --Summary of data of deposits examined in northeastern New York (fig. 4)--Continued.

Name and location	Radioactivity (mr/hr or null if less than 0.03 mr/hr)	Sample number	Geology and remarks
Russia Station mine 2/ Along Delaware and Hudson railroad at southern end of Johnson Mountain, 4 miles north of Redford, Clinton County	null	---	Magnetite in pyroxene, hornblende, plagioclase gneiss; pyroxene-microantiperthite granite gneiss footwall; hypersthene amphibolite hangingwall; Lyon Mountain granite gneiss formation, pre-Cambrian.
Rutgers mine 2/ See page 14 of this report			
Mitchell prospect 2/ Near east bank of Little Ausable River, 7 miles north of Ausable Forks, Clinton County	null	---	Magnetite in granitized skarn, quartzose skarn and sheared quartz. Lyon Mountain granite gneiss formation, pre-Cambrian.
Arnold Hill mines 2/ 3 miles northeast of Ausable Forks, Clinton County	0.03	---	Three ore bodies: gray vein, magnetite with light-colored gangue; black vein, magnetite; blue vein, martite with vein quartz and ferruginous calcite. Lyon Mountain granite gneiss formation, pre-Cambrian Material on dump looks rich in magnetite and martite(?).

Table 2. --Summary of data of deposits examined in northeastern New York (fig. 4)--Continued.

Name and location	Radioactivity (mr/hr or null if less than 0.03 mr/hr)	Sample number	Geology and remarks
Palmer Hill group of mines 2/ 2 miles north of Ausable Forks, Clinton County	null	---	Magnetite disseminated in medium-grained microperthite-microcline granite gneiss of Lyon Mountain formation, pre-Cambrian age. Large masses of fluorite reported found during mining. Radioactive spots in pegmatitic facies of gneiss. Radioactive minerals are sphene, allanite, and zircon.
Black Brook mines 2/ In village of Black Brook, Clinton County	do.	---	Magnetite-bearing quartz-feldspar pegmatite in Lyon Mountain granite gneiss formation, pre-Cambrian age.
attie mine 2/ 8 miles northeast of Ausable Forks, Clinton County	0.07 max. 0.03	FK-42	Three ore zones; lower one contains active mineral lessingite and is magnetite that has replaced micro-antiperthite gneiss. Hanging wall is pink pyroxene granite gneiss; foot-wall is biotite-plagioclase granite gneiss, skarn in hanging wall of lower zone is slightly radio active (0.05-0.07 mr/hr).
re Bed Point About 4 miles northeast of Westport, along west shore of Lake Champlain, Essex County	null	---	Magnetite-hornblende-biotite rock presumably is the ore; country rock is hornblende gneiss.

Table 2. --Summary of data of deposits examined in northeastern New York (fig. 4)--Continued.

Name and location	Radioactivity (mr/hr or null if less than 0.03 mr/hr)	Sample number	Geology and remarks
Furnace Point (slag dump) 1 mile northeast of Westport, along west shore of Lake Champlain, Essex County	0.10 max. ---	FK-89 FK-90	Slag dump of old iron furnace. Magnetite ore, slag and iron puddles in vicinity. Slag is only material that is active.
Little Pond mine 3/ Several hundred yards north of Little Pond, 2 miles south of Elizabethtown, Essex County	null	---	Titaniferous magnetite ore body in dark green gabbro.
Lincoln Pond mine 3/ About 500 feet west of south end of Lincoln Pond, Essex County	do.	---	Ore is fine- to medium-grained magnetite-biotite-feldspar rock gradational to a hypersthene gabbro. Few pyrite veinlets cut ore.
Smith mine About 3 miles southwest of Westport on farm of Charlie Smith, Essex County	do.	---	Magnetite ore body in gabbro; probably high in titanium; parts are rich in garnet and amphibole.
Close mine About 3.5 miles southwest of Westport on farm of Hughy Close, Essex County	do	---	Magnetite ore body in hornblende gneiss.
Ledge Hill roadcut 2 miles southwest of Westport, Essex County	0.10 max.	FK-92	Silicified granite gneiss; little pyrite; altered feldspar. Silicified part is all that is active.

3/ Kemp, J. F., 1908

Table 2. —Summary of data of deposits examined in northeastern New York (fig. 4)—Continued

Name and location	Radioactivity (mr/hr or null if less than 0.03 mr/hr)	Sample number	Geology and remarks
Mineville mines See page 16 of this report	---	---	--------
Cheever mines About 2 miles north of Port Henry, $\frac{1}{4}$ miles west of Lake Champlain.	---	FK-88	Magnetite ore body in green syenitic gneiss, near Grenville limestone of pre-Cambrian age. Resembles Old Bed ore at Mineville.
Craig Harbor prospect About $\frac{1}{4}$ mile north of northermost boathouse in Port Henry, along Delaware and Hudson railroad tracks, Essex County	null	---	Magnetite-rich gabbro, probably high in titanium.
Hammondville mines About 10 miles southwest of Crown Point, Essex County	do.	---	Ore is magnetite-quartz-chlorite-garnet rock.
Lawrence prospects On Sugar Hill about 1.5 miles southwest of Crown Point, Esses County	0.03	---	Three prospects: "phosphate pit", feldspar-quartz pegmatite with few grains of black radioactive mineral; magnetite prospect in magnetite-quartz-biotite-pyrite rock; magnetite prospect in magnetite-garnet-feldspar-hornblende-biotite rock.

Table 2. --Summary of data of deposits examined in northeastern New York (fig. 4)--Continued.

Name and location	Radioactivity (mr/hr or null if less than 0.03 mr/hr)	Sample number	Geology and remarks
Vineyard mine 3/ At northeast foot of Buck Mountain, along Crown Point Street, 2.5 miles south of Crown Point, Essex County	null	---	Magnetite ore body in hornblende gneiss of Grenville formation, pre-Cambrian age.
Lake Sanford mines 3,4/ Operated by National Lead Company at Tahawus Club along Sanford and Henderson Lakes, Essex County	null	---	Titaniferous magnetite deposits in gabbro and Marcy anorthosite.

4/ Stephenson, R. C., 1945

Table 3.--Summary of data of deposits examined in St. Lawrence County, New York (fig. 3)

Name and location	Radioactivity (mr/hr or null if less than 0.03 mr/hr)	Sample number	Geology and remarks
Clifton mines 3,5/ About 4 miles southeast of Degrasse, St. Lawrence County	--- null ---	FK-53 FK-53A FK-57	Massive magnetite as replacement of skarn in hornblende schist and gneiss. Very small amount of uraninite found in one outcrop of massive magnetite and large boulder of skarn (Samples FK-53, and 57); uraninite also in pegmatite. Maximum of 0.2 mr/hr on face of uraninite-bearing magnetite.
Jayville mines 5,6/ About 7 miles southwest of Fine, St. Lawrence County	null	---	Magnetite ore body between hanging wall of pink, hornblende granite gneiss and footwall of garnet-pyroxene skarn. Ore near footwall contains pyrrhotite.
Benson mines See page 12 of this report	---	---	-------
Green prospect 6/ 2 miles south of Fine, St. Lawrence County	null	---	Contact metamorphic deposit at contact of granite gneiss with limestone. Mineralized zone contains magnetite, hematite, pyroxene, phlogopite(?), calcite, and scapolite(?).
Fullerville Iron works 5 miles north of Balmat, St. Lawrence County	do.	---	Probably a contact metamorphic deposit of magnetite and hematite. Only outcrops observed were talc schist with skarn pods of calcite pyroxene and garnet.

3/ Kemp, J. F., 1908
5/ Leonard, B. F., 1952
6/ Dale, N. C., 1935

Table 4.--Summary of data of deposits examined in southeastern New York, New Jersey, and eastern Pennsylvania (fig. 5)

Name and location	Radioactivity (mr/hr or null if less than 0.03 mr/hr	Sample number	Geology and remarks
Forest of Dean mine 7/ Now under reservoir on West Point Military Academy land about 8 miles northwest of Peekskill, N.Y.	null	---	Pieces of rock and ore along bank of reservoir indicate the ore body was coarse-grained magnetite with calcite; country rock probably a pink, coarse-grained granite.
Holland Furnace 7/ Near mouth of Peekskill Creek at south end of Jan Peck bridge, Westchester County, N. Y.	do.	---	Site of old iron furnace. Few pieces of slag found; no ore.
Continental Village mines 7/ Along Sprout Brook about 2 miles north of Peekskill, Putham County, N. Y.	do.	---	Magnetite in hornblende gneiss. Pyrite, calcite, serpentine, hornblende and quartz are gangue minerals.
DeLuca emery mine Near Dickinson Pond, about 3 miles southeast of Peekskill, Westchester County, N. Y.	do.	---	Dense, fine-grained, magnetite-corundum rock in contact zone of Manhattan schist and gabbro. Biotite, garnet, and cordierite(?) also abundant.
Sterling Furnace mines At Sterling Furnace, Orange County, N. Y.	do.	---	Magnetite ore bodies as replacements of gneiss of pre-Cambrian age.

7/ Berkey, C. P., and Rice, Marion, 1919

Table 4.--Summary of data of deposits examined in southeastern New York, New Jersey, and eastern Pennsylvania (fig. 5)--Continued.

Name and location	Radioactivity (mr/hr or null if less than 0.03 mr/hr)	Sample number	Geology and remarks
Ringwood mines 8/ About 4 miles east of south end of Greenwood Lake at Ringwood, Passaic County, N. J.	null	---	Several magnetite ore bodies. Magnetite replacement of Pochuck gneiss of pre-Cambrian age. Pegmatites cut gneiss. One crystal of monazite found in pegmatite float at Cannon mine. Nothing else radioactive.
Derenberger mine 8/ In village of Schooleys Mountain, about 10 miles southwest of Netcong, Morris County, N. J.	do.	---	Examined dump(?) rock along road at supposed site of mine.
Stoutenberg mine 8/ On Stevens farm, 8 miles southwest of Netcong, Morris County, N. J.	do.	---	No outcrops; workings completely filled and now farmland. Rock piles in field contain few lumps of magnetite ore.
Copper mine 8/ 9 miles southwest of Dover, Morris County, N. J.	do.	---	Magnetite-hematite ore in hornblende gneiss similar to ore at Hacklebarney mines. Pyrite and biotite also present.
Hacklebarney group of mines 9/ Along Black River about 12 miles southwest of Dover, N. J.	do.	---	Mixture of hematite and magnetite in gneiss. Reported to contain much sulfur (pyrite) at depth but deep weathering oxidized the pyrite in upper parts.

8/ Bayley, W. S., 1910
9/ Sims, P. K., (In preparation)

Table 4.--Summary of data of deposits examined in southeastern New York, New Jersey, and eastern Pennsylvania (fig. 5)--Continued.

Name and location	Radioactivity (mr/hr or null if less than 0.03 mr/hr)	Sample number	Geology and remarks
Busche graphite mine About 15 miles northeast of Dover on property of Fred Busche, Morris County, N. J.	null	---	Biotite-graphite layers in schist U. S. Bureau of Mines has sampled the property extensively.
Kahart mine 8/ About 12 miles northeast of Dover, Morris County, N. J.	do.	---	Massive- to coarse-grained magnetite ore body in fine-grained feldspar-quartz-magnetite gneiss; enrichment of biotite near ore gneiss contact.
Jackson mine 8/ 16 miles northeast of Dover in back of Pompton Crushed Stone Co., quarry, Morris County, N. J.	0.17	FK-139	Reported to be a small vein of magnetite cut by pegmatite. However, outcrops are magnetite-bearing pegmatite in hornblende gneiss. Minerals in pegmatite found on dump are: magnetite, quartz, feldspar, hornblende, pyrite, chalcopyrite, allanite, and zircon. Allanite and zircon are radioactive.
Taylor mine 8/ 0.2 miles north of road junction at Taylortown along road to Butler, 10 miles northeast of Dover, Morris County, N. J.	null	---	Shallow pits and small dumps; hornblende-feldspar gneiss and a little tourmaline-feldspar pegmatite, no magnetite observed.

Table 4.--Summary of data of deposits examined in southeastern New York, New Jersey, and eastern Pennsylvania (fig. 5)--Continued.

Name and location	Radioactivity (mr/hr or null if less than 0.03 mr/hr)	Sample number	Geology and remarks
Scrub Oaks mine 8,9/ About 2 miles west of Dover, Morris County, N. J.; operated by Alan Wood Steel Company	null	FK-104	Large low-grade deposit of magnetite disseminated in quartz-feldspar-magnetite gneiss.
Richard mine 8,9/ 2 miles north of Dover, Morris County, N. J., operated by Colorado Fuel and Iron Company.	0.04	FK-99	Magnetite replacement of Pochuck and Losee gneisses. Syenite pegmatite in some of drill core is slightly active (0.04 mr/hr). Minerals are magnetite, pink feldspar, biotite, calcite.
Birch mine 8/ 8 miles northeast of Dover, Morris County, N. J.	null	---	Magnetite in quartz-feldspar-hornblende gneiss.
Gold diggings prospect 8,9/ About 1 mile north-northeast of Mount Hope mine, 2 miles north of Dover, Morris County, N. J.	do.	---	Lean magnetite ore in feldspar-quartz-hornblende gneiss.
Mount Hope mine 8,9/ 2 miles north of Dover, Morris County, N. J.	0.04 ---	FK-97 FK-98	Massive and disseminated magnetite ore bodies as replacements of quartz-feldspar-hornblende-pyroxene gneiss.
Canfield phosphate mine See page 19 of this report	---	---	------

Table 4.--Summary of data of deposits examined in southeastern New York, New Jersey, and eastern Pennsylvania (fig. 5)--Continued.

Name and location	Radioactivity (mr/hr or null if less than 0.03 mr/hr)	Sample number	Geology and remarks
Swayze mine 8/ 6 miles northwest of Clinton, Hunterdon County, N. J.	null	---	Massive magnetite and magnetite intergrown with hornblende and green mica. Rock on dump is feldspar-quartz granite gneiss.
VanSyckles mine 4 miles northwest of Clinton, Hunterdon County, N. J.	do.	---	Feldspar-quartz gneiss on dump; magnetite ore bodies reported to be interlayered with chlorite rock; ore is reported to contain 12 percent TiO_2 and 0.38 percent vanic acid. Minerals present are magnetite, chlorite, hornblende, epidote, pyrite, feldspar, quartz.
Neighbors mine 8/ On N. J. Highway 513, about 8 miles northeast of Clinton, Hunterdon County, N. J.	do.	---	Limonite, hematite, and pyrite in Kittatinny limestone of Cambrian age.
Welch mine 8/ 10 miles northeast of Clinton, Hunterdon County, N. J.	do.	---	Gneiss and pegmatite float; hematite and manganese oxide coats some of rock. Parts of some of the pegmatite were slightly radioactive.
Cokesbury mine 8/ 6 miles northeast of Clinton, Hunterdon County, N. J.	do.	---	Hornblende-magnetite gneiss on dump(?).

Table 4.--Summary of data of deposits examined in southeastern New York, New Jersey, and eastern Pennsylvania (fig. 5)--Continued.

Name and location	Radioactivity (mr/hr or null if less than 0.03 mr/hr)	Sample number	Geology and remarks
High Bridge mine 8/ Along Mine road in High Bridge, 3 miles northeast of Clinton, Hunterdon County, N. J.	null	---	Magnetite ore body in hornblende-magnetite gneiss.
Silverthorne mine 8/ 3 miles northeast of Clinton, Hunterdon County, N. J.	do.	---	Magnetite ore body in hornblende-magnetite gneiss; very rich in hornblende in some places, judging from rock on dump.
Annandale graphite mine On property of N. J. Reformatory at Annandale 2 miles east of Clinton, Hunterdon County, N. J.	0.05 max.	---	Graphite schist cut by pegmatite. Parts of pegmatite slightly radioactive.
Large mine 8/ About 2 miles southeast of Clinton, Hunterdon County, N. J.	null	---	Magnetite ore body in Pochuck gneiss cut by pegmatite. In places hornblende replaces magnetite. Ore on dump commonly has pyrite mixed with it.
Cascade and Allis mine 8/ On east side of Sussex railroad about 2.5 miles north west of Netcong, Sussex County, N. J.	do.	---	Magnetite ore bodies in zone of coarse amphibolite between Pochuck and Losee gneisses. Most of the hemlock trees in the area are growing on the amphibolite zone.
Andover mines 8,10/ About 1.75 miles north-northeast of Andover, Sussex County, N. J.	0.07-0.1 max.	FK-117	Hematite-magnetite deposit in biotite-feldspar-quartz gneiss. Part of hanging wall gneiss is radioactive. Ore zone is not active.

10/ Sims, P.K. and Leonard, B. F., 1952

Table 4.--Summary of data of deposits examined in southeastern New York, New Jersey, and eastern Pennsylvania (fig. 5)--Continued.

Name and location	Radioactivity (mr/hr or null if less than 0.03 mr/hr)	Sample number	Geology and remarks
Sulfur Hill mine 8,10/ About 1.75 miles north-northeast of Andover, Sussex County, N. J.	null	---	Magnetite-sulfide deposit as replacement of skarn. Minerals are magnetite, garnet, calcite, quartz, sphalerite, galena, chalcopyrite, pyrite, malachite, willemite, azurite, hematite, limonite, talc, biotite, epidote, fluorite, and hornblende.
Mulligan quarry See page 20 of this report.	---	---	-------
Marble Mountain See page 22 of this report.	---	---	-------
Rock Products Co. quarry About 2 miles north of Phillipsburg, Warren County, N. J.	null	---	Light green to gray green serpentine and talc in Franklin limestone formation of Pre-Cambrian age.
Carpentersville mine 8/ About 3 miles south of Phillipsburg, Warren County, N. J.	do.	---	Limonite-hematite deposit in fault zone between Kittatinny limestone of Cambrian age and gneiss of pre-Cambrian age.
Pequest furnace 8/ 16 miles northeast of Phillipsburg, Warren County, N. J.	do.	FK-137	Slag dump of old iron furnace.

Table 4.--Summary of data of deposits examined in southeastern New York, New Jersey, and eastern Pennsylvania (fig. 5)--Continued.

Name and location	Radioactivity (mr/hr or null if less than 0.03 mr/hr)	Sample number	Geology and remarks
Warren Furnace 22 miles northeast of Phillipsburg, Warren County, N. J.	null	---	Slag dump of old iron furnace.
Beatyestown mine 8/ 20 miles northeast of Phillipsburg, Warren County, N. J.	do.	---	Limonite and iron carbonates in Kittatinny limestone of Cambrian age.
Edison quarry 8/ About 13 miles northeast of Phillipsburg, Warren County, N. J.	0.2 max.	---	Silicated Franklin limestone of pre-Cambrian age. Minerals present are white and smoky quartz, feldspar, hornblende, graphite, idiocrase(?), graphite, magnetite, fine-grained galena, tourmaline, pyrite, fluorite, zircon, biotite, and, very rarely, uraninite. No radioactive minerals found at outcrops, only in a few boulders in dump of waste rock.
Raub mine 8/ Several hundred feet northeast of Edison quarry, 13 miles northeast of Phillipsburg, Warren County, N. J.	null	---	Ore is reported to be an earthy mixture of manganiferous limonite, magnetite, and a little sphalerite in Franklin limestone of pre-Cambrian age. No outcrops; material on dumps is not radioactive.

Table 4.--Summary of data of deposits examined in southeastern New York, New Jersey, and eastern Pennsylvania (fig. 5)--Continued.

Name and location	Radioactivity (mr/hr or null if less than 0.03 mr/hr)	Sample number	Geology and remarks
Mitchell mine 8/ 17 miles northeast of Phillipsburg, Warren County, N. J.	0.04	FK-135 FK-136	Magnetite-bearing pegmatite as judged from material on dump. Some of the pegmatite is slightly radioactive.
Poronowicz farm Northwest side of village of Oxford Furnace, Warren County, N. J.	0.2 max.	FK-115	Quartz-feldspar pegmatite with a little magnetite and monazite. Detected with carborne Geiger counter.
Belvidere group, southern part 8/ Part composed of Queen, Riddle, and Little (Fellows) mines, about 1 mile north of Oxford Furnace, Warren County, N. J.	0.16 max.	FK-109 FK-110 FK-111 FK-112 FK-113	Mixture of limonite and magnetite rock on dumps; compact magnetite with calcite is reported at depth. Deposit is in Franklin limestone of pre-Cambrian age. Much of the dump material has weathered to a ferruginous clayey soil with a little mica. A 25- by 100-foot area of this material near Little mine is radioactive. Most radioactive part seems to be upper few inches, which is black topsoil rich in organic matter.
Crane mine 8/ ½ mile northwest of Bartley, Morris County, N. J.	null	---	Magnetite-bearing feldspar-quartz-hornblende pegmatite in medium-grained quartz-feldspar-hornblende gneiss.

Table 4.--Summary of data of deposits examined in southeastern New York, New Jersey, and eastern Pennsylvania (fig. 5)--Continued.

Name and location	Radioactivity (mr/hr or null if less than 0.03 mr/hr)	Sample number	Geology and remarks
Washington mine 8/ About 2 miles south of Oxford Furnace, Warren County, N. J. Currently operated by Alan Wood Steel Co.	null	FK-102	Magnetite ore body in pre-Cambrian gneiss and pegmatite.
Ahles mine 8/ In the Belvidere group of mines, about 1 mile north of Oxford Furnace, Warren County, N. J.	do.	---	Manganiferous hematite-magnetite-limonite ore body in Franklin limestone of pre-Cambrian age.
Oxford Furnace 8/ About ½ mile south of village of Oxford Furnace, Warren County, N. J.	do.	FK-101	Probably part of same ore body being mined at Washington mine. Dump rock is magnetite ore with much hornblende.
Oxford Furnace slag dump In village of Oxford Furnace, Warren County, N. J.	0.05	FK-100	Slightly radioactive slag from old iron furnace.

Table 4.--Summary of data of deposits examined in southeastern New York, New Jersey, and eastern Pennsylvania (fig. 5)--Continued.

Name and location	Radioactivity (mr/hr or null if less than 0.03 mr/hr)	Sample number	Geology and remarks
Ogden mines 8/ At Edison, 3 miles south of Franklin, Sussex County, N. J.	0.10 av.	FK-95	Examined large open cut at Edison mine and dump of unknown mine about ½ mile northeast of open cut. Sulfide rich, magnetite ore body in gneiss. Hanging wall of open cut is pegmatitic, very rich with sulfides, though very weathered, and radioactive. Dump of unknown mine is not radioactive but contains rock with a little copper staining. A great variety of minerals are reported from this locality and include garnet, apatite, molybdenite, kyanite, pyrite, chalcopyrite, and magnetite.
Chestnut Hill See page 22 of this report (fig. 6)	---	---	-------
Williams quarry See page 22 of this report (fig. 6)	---	---	-------
Morgan Hill mines 11/ On north side of Morgan Hill, south side of town of Easton, Northampton County, Pa.	null	FK-149	Limonite-hematite ore in Kittatinny limestone of Cambrian age where it is in fault(?) contact with underlying Hardyston formation or pre-Cambrian gneiss.

11/ Bayley, W. S., 1941

Table 4.--Summary of data of deposits examined in southeastern New York, New Jersey, and eastern Pennsylvania (fig. 5)--Continued.

Name and location	Radioactivity (mr/hr or null if less than 0.03 mr/hr)	Sample number	Geology and remarks
Durham Furnace mines (Rattlesnake Hill) 11/ On Rattlesnake Hill, 1 mile southwest of Durham Furnace, Bucks County, Pa.	0.05 max.	FK-151 FK-152	Magnetite disseminated or as bands in very quartzitic gneiss. Gneiss also contains a little graphite.
Durham Furnace 11/ At Durham Furnace, Bucks County, Pa.	null	FK-150	Slag from old iron furnace being used as road metal.
Durham mines (Mine Hill) 11/ On Mine Hill about 2 miles southwest of Durham Furnace Bucks County, Pa.	do.	FK-153	Disseminated and massive magnetite in Byram(?) gneiss of pre-Cambrian age.
Boyer and Kohl mines 11/ About 2.5 miles southwest of Durham Furnace, Bucks County, Pa.	do.	---	Dumps have well-banded quartz-magnetite-chlorite rock. Hematite in vein(?) quartz is also common. Some of the hematite has polysynthetic twinning.
Birmingham marl pit At Birmingham, 4 miles east, southeast of Mount Holly, Burlington County, N. J.	0.04	FK-167 FK-168	Black to blue-black glauconitic sands of Hornerstown formation, of upper Cretaceous age. Blue earthy mineral present, probably vivianite.

Table 4.--Summary of data of deposits examined in southeastern New York, New Jersey, and eastern Pennsylvania (fig. 5)

Name and location	Radioactivity (mr/hr or null if less than 0.03 mr/hr)	Sample number	Geology and remarks
Reeves Station marl pit 2 miles north of Medford, Burlington County, N. J.	0.04	FK-1	Black to green glauconitic sands of Hornerstown formation, of upper Cretaceous age. "Iron stone" full of shell casts.
		FK-2	
		FK-3	
		FK-4	
		FK-5	
		FK-6	
		FK-7	
		FK-8	
		FK-9	
		FK-10	
Marlton roadcut About 5 miles east of Medford, Burlington County, N. J.	---	FK-1	Reworked greensand marl about 4 feet thick, probably deposited in Pleistocene time.

Table 5.—Assay results of samples a/

Sample number	Name of Locality	Equivalent uranium (percent)	Uranium (percent)	Description and remarks
FK-1	Marlton	0.002		Clayey greensand.
FK-2	Reeves Station	.005		Dried fine greensand from screen.
FK-3	do.	.004		Medium-sized material from screen. 1/8"-3/16" in diameter.
FK-4	do.	.005		Coarse rejects from screen.
FK-5	do.	.004		Black glauconitic sand from bottom of pit.
FK-6	do.	.004		18" channel of limonitic shelly greensand from 2' bed.
FK-8	do.	.004		Zeolite product, heated type.
FK-9	do.	.004		Zeolite product, cold type.
FK-10	do.	.004		Waste fines and excess chemicals.
FK-21	Starkey Corners molybdenum prospect	.003		Coarse-grained granite, with pyrite.
FK-22	do.	.003		Do.
FK-23	do.	.003		Do.
FK-24	do.	.003		Do.

a/ All laboratory work, except the analyses of plants, was done in the Trace Elements Section Washington Laboratory. The plant analyses were made in the Trace Elements Section Denver Laboratory.

Table 5.--Assay results of samples a/--Continued.

Sample number	Name of Locality	Equivalent uranium (percent)	Uranium (percent)	Description and remarks
FK-25	Starkey Corners molybdenum prospect	0.001		Dark, greenish, coarse-grained contact metamorphic rock with lime silicates.
FK-26	do.	.001		Vein quartz containing molybdenite, fluorite, and galena.
FK-27	Drew Hill sulfide prospects	.001		Vein quartz with stibnite and pyrite.
FK-28	do.	.001		Vein quartz with galena.
FK-29	Littleton Ridge manganese prospect	.001		Manganiferous shale.
FK-30	Winterville roadcut	.001		Rhyolite with malachite on fracture surfaces.
FK-36	Averill mine	.004		Lyon Mountain granite gneiss.
FK-37		.001		Magnetite concentrates.
FK-39	Chateaugay mine	.003		Tailings.
FK-42	Battie mine	.010		Coarse-grained quartzitic magnetite ore.
FK-51	Rutgers mine	.006		Magnetite ore with microcline, oligoclase, apatite, hornblende, pyroxene, and zircon.
FK-52	do.	.003		Pyroxene skarn in granite gneiss.

Table 5.--Assay results of samples a/--Continued.

Sample number	Name of Locality	Equivalent uranium (percent)	Uranium (percent)	Description and remarks
FK-53	Clifton mine	0.002		Massive magnetite ore. 4'9" channel sample from hanging wall contact.
FK-53A	do.	.001		Tailings.
FK-57	do.	.008		Pyroxene skarn boulder, with augite calcite, apatite, and uraninite.
FK-59	Benson mine	.017		Magnetite ore from disseminated garnet zone in hanging wall, with magnetite, quartz, garnet, feldspar, biotite, and allanite.
FK-60	do.	.002		Gneiss from hanging wall.
FK-61	do.	.002		Magnetite ore from disseminated garnet zone near small anticline.
FK-63	do.	.006		Oxidized brown material on float from hanging wall.
FK-65	do.	.001		Magnetite concentrates.
FK-66	do.	.006		Magnetite tailings.
FK-67	do.	.002		Martite concentrates.
FK-68	do.	.006		Martite tailings.
FK-72	Mineville mines	.002		Old Bed tailings processed for apatite in fertilizer plant.

Table 5.--Assay results of samples a/ --Continued.

Sample number	Name of Locality	Equivalent uranium (percent)	Uranium (percent)	Description and remarks
FK-73	Mineville mines	0 012	0.004	Old Bed apatite rich tailings, unprocessed. Spectrographic analysis shows: Si, over 10%; Ce, La, Y, 0.1-1-0%; Mn, Gd, Ti, B, Sr, Zr, 0.01-0.1%; Ni, Yb, Co, Lu, Ho, Sn, Ba, Sc, Cr, Cu, 0.001-0.01%.
FK-73A	do.	.009	.003	Old Bed tailings, unprocessed and more representative than FK-73. Quartz, oligoclase, apatite, magnetite, pyroxene, hornblende, biotite, muscovite.
FK-75	do.	.003	.003	Old Bed magnetite ore from Joker mine. Spectrographic analysis shows: Ca, Si, Al, Mg, Na, 0.1-1.0%; Ce, Y, Ti, Mn, La, Sn, 0.01-0.1%; Co, Ni, Cu, Zr, 0.001-0.01%.
FK-76	do.	.015		Apatite rich tailings washed into road near Joker mine just east of Don B hoist rig.
FK-77	do.	.005	.002	Tailings, from dump just east of Don B hoist rig.
FK-78	do.	.002		Coarse fraction of FK-77.
FK-79	do.	.004	.001	Tailings from No. 7 mill.
FK-80	do.	.004		Slime pond material.
FK-81	do.	.007		Old Bed rougher tailings.

Table 5.--Assay results of samples a/--Continued.

number	Name of Locality	Equivalent uranium (percent)	Uranium (percent)	Description and remarks
FK-82	Mineville mines	0.002		Old Bed "O" coarse tailings.
FK-83	do.	.012		Old Bed finisher tailings.
FK-84	do.	.001		Old Bed concentrates.
FK-85	do.	.001		Harmony concentrates.
FK-86	do.	.001		Fisher Hill concentrates.
FK-88	Cheever mine	.011		Magnetite ore from dump.
FK-89	Furnace Point	.018	0.006	Slag from furnace at Furnace Point.
FK-90	do.	.002		Magnetite ore found near furnace at Furnace Point.
FK-92	Ledge Hill roadcut	.005		Silicified granite gneiss.
FK-93	Canfield phosphate mine	.003	.002	Magnetite rich rock, probably ore.
FK-94	do.	.007-.009	.004	Magnetite ore, with quartz, apatite, monazite, and limonite stain.
FK-95	Ogden mines	.007	.005	Wall rock of quartz, albite, garnet, magnetite, pyrite, and biotite from S end, E wall of E tongue of large open cut.
FK-96	do.	.005	.002	Tailings, south of mill.
FK-97	Mt. Hope mine	.003	.002	Tailings from new pile.

Table 5.--Assay results of samples a/--Continued.

Sample number	Name of Locality	Equivalent uranium (percent)	Uranium (percent)	Description and remarks
FK-98	Mt. Hope mine	0.001		Magnetite ore, lump.
FK-99	Richard mine	.002		Fine tailings.
FK-100	Oxford Furnace slag dump	.004	0.002	Slag from old furnace.
FK-101	Oxford Furnace	.001		Magnetite ore from dump of mine opposite cemetery 1 mile south of Oxford Furnace.
FK-102	Washington mine	.003		Tailings.
FK-103	do.	.001		Tailings.
FK-104	Scrub Oaks mine	.001		Magnetite concentrates.
FK-109	Fellows mine	.002	.002	Yellow white clay, weathered dump material.
FK-110	do.	.013	.005	Black topsoil from upper 3 inches of ground at same locality as FK-109. Contains 0.018 percent ThO_2
FK-111	do.			Leaves and twigs from silver maple tree growing in radioactive soil. Analyses show 5.8 percent ash, U in ash-0.7 ppm., Mn in ash-0.21 percent ThO_2 in ash-0.002 percent.

Table 5.--Assay results of samples a/ --Continued.

Sample number	Name of Locality	Equivalent uranium (percent)	Uranium (percent)	Description and remarks
FK-112	Fellows mine			Leaves and twigs from cat brier vine. Ash-4.4 percent, U in ash-0.8 ppm., Mn in ash-0.35 percent, Th in ash-0.002 percent. Same locality as FK-109.
FK-113	do.			Leaves and twigs of sarsaparilla plants. Ash-11.5 percent, U in ash-1.2 ppm., Mn in ash-0.60 percent, Th in ash-0.002 percent. Same locality as FK-109.
FK-115	Poronowicz farm	0.040	0.008	Pegmatitic rock with feldspar, quartz, magnetite, and monazite; from outcrop on east side of road, behind barn.
FK-117	Andover mine	.005	.003	Quartzite and black shaly rock.
FK-123	Marble Mountain	.005	.003	Fine-grained schist, with quartz, chlorite, magnetite, hematite, and sericite. Sample taken from very top of Marble Mountain.
FK-124	do.			Leaves and twigs of maple tree growing in radioactive soil about 75 feet SW of locality FK-123. Ash-6.8 percent, U in ash-0.8 ppm., Mn in ash-0.09 percent, Th in ash-0.002 percent.
FK-125	do.	0.030	0.005	Quartz, feldspar, magnetite, hematite schist. Main portion of rock from which sample was taken appears to be sheared pegmatite. Sample taken about 200 feet southwest of crest of Marble Mountain.

Table 5.--Assay results of samples a/--Continued.

Sample number	Name of Locality	Equivalent uranium (percent)	Uranium (percent)	Description and remarks
FK-126	Marble mountain			Laurel leaves; from bush growing in radioactive soil about 150 feet northwest of crest of southwest end of ridge. Ash-2.8 percent, U in ash-0.5 ppm., Mn in ash-0.01 percent, Th in ash-0.016 percent.
FK-127	do.	0.009	0.002	Talc schist, from site about 200 feet southwest of first large pit on southwest end of radioactive ridge. Contains 0.014 percent ThO_2.
FK-128	Mulligan quarry	.049	.046	Chips of 4-inch black layer in limestone, taken from about 2 feet to 5 feet from slickensided rock in north quarry.
FK-129	do.	.008	.007	Chips of white limestone with coating of yellow-green mineral. From northern part of quarry.
FK-130	do.	.001	.001	Light gray limestone from "active" interval of north end of quarry.
FK-131	do.	.001		Limestone from "inactive" interval of quarry.
FK-132	do.	.008		Brecciated limestone from southernmost shear zone in quarry.
FK-133	Peters mine	.001		Tailings, Peters mine.
FK-135	Mitchell mine	.005		Pegmatitic magnetite ore.

Table 5.--Assay results of samples a/--Continued.

Sample number	Name of Locality	Equivalent uranium (percent)	Uranium (percent)	Description and remarks
FK-136	Mitchell mine	0.001		Magnetite-bearing pegmatite, with quartz, magnetite, apatite, zircon, and limonite stain. From pile of rocks southeast of Mitchell mine shaft.
FK-137	Pequest Furnace	.004	0.002	Slag from dump.
FK-139	Jackson mine	.025	.002	Magnetite-bearing pegmatite rock from dump.
FK-141	do.	.001		Magnetite-bearing pegmatite.
FK-144	do.	.010	.001	Magnetite ore, grab sample from dump near pipeline. Contains 0.020 percent ThO_2. Magnetite, pyrite, quartz, chalcopyrite, hornblende, zircon, and allanite.
FK-145	Williams quarry	.004		Pickering gneiss from behind Easton water works.
FK-149	Morgan Hill mines	.005		Limonite-hematite ore, with quartz, near shaft of mine on north side of Morgan Hill.
FK-150	Durham Furnace	.002		Slag from dump.
FK-151	Durham Furnace mines	.003		Feldspar-quartz-magnetite rock from site about 20 feet west of easternmost tunnel on northeast side of Rattlesnake Hill.

Table 5.--Assay results of samples a/--Continued.

Sample number	Name of Locality	Equivalent uranium (percent)	Uranium (percent)	Description and remarks
FK-152	Durham Furnace mines	0.003		Massive magnetite ore, from third tunnel west from eastern end of Durham Mines.
FK-153	do.	.001		Magnetite ore, grab sample from dump.
FK-154	Chestnut Hill	.004		Pegmatitic rock with quartz, feldspar, chlorite, and mica. From site about 4,000 feet southwest of route 115 on Chestnut Hill.
FK-155	do.	.015	0.008	Pegmatite with quartz, feldspar, biotite, hornblende and magnetite. Float rock on top of Chestnut Hill about 340 feet north of burned hotel.
FK-157	do.	.003	.002	Pegmatite in granite outcrop at Anthony's Nose, 1 mile north of Easton.
FK-163		.002		Hematite-magnetite ore from large underground room on Marble Mt.
FK-164	Marble Mountain	.022	.003	Slaty green quartzite from first trench about 150 feet north of northernmost prospect pits on top of Marble Mountain.
FK-165	do.	.022	.005	Sheared quartz-sericite metamorphic rock with minute green elongate unidentified crystals and abundant limonite stain. From second pit south of site of FK-164.

Table 5.--Assay results of samples a/

Sample number	Name of Locality	Equivalent uranium (percent)	Uranium (percent)	Description and remarks
FK-166	Marble Mountain	0.044		Sheared quartz-sericite rock like FK-165, from site about 150 feet N. 30° E. of highest point of Fulmer mine area.
FK-167	Birmingham marl pit	.003		Blue-black glauconitic sand. Six-inch channel from northeast part of pit.
FK-168	do.	.004		Brown-black glauconitic sand. 1.5-foot channel sample from same locality as FK-167.
FK-169	do.	.004		Dark green glauconitic sand. Grab sample from stockpile near road.

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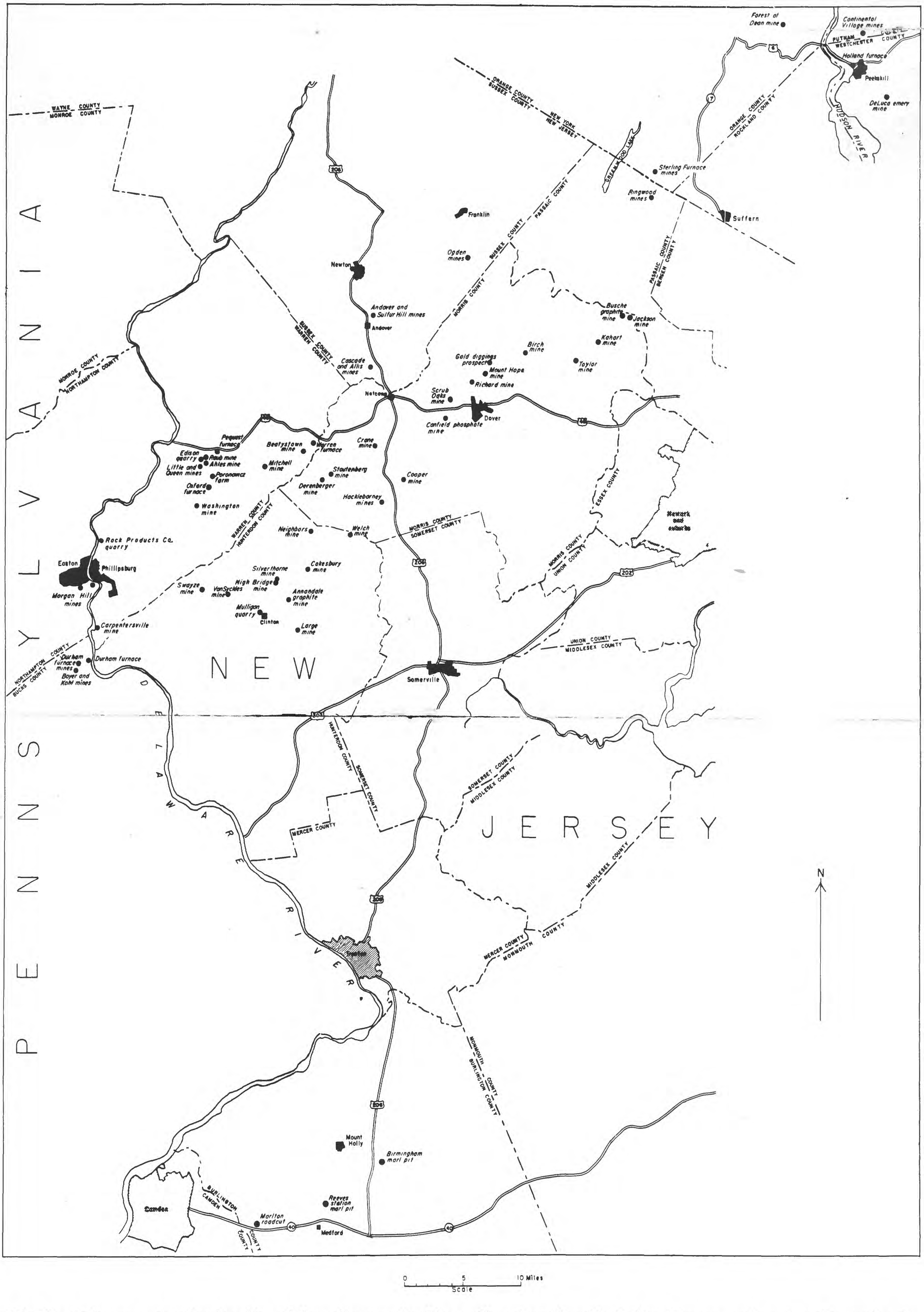

Fig. 5—Index map showing location of deposits examined in southeastern New York, New Jersey, and eastern Pennsylvania.

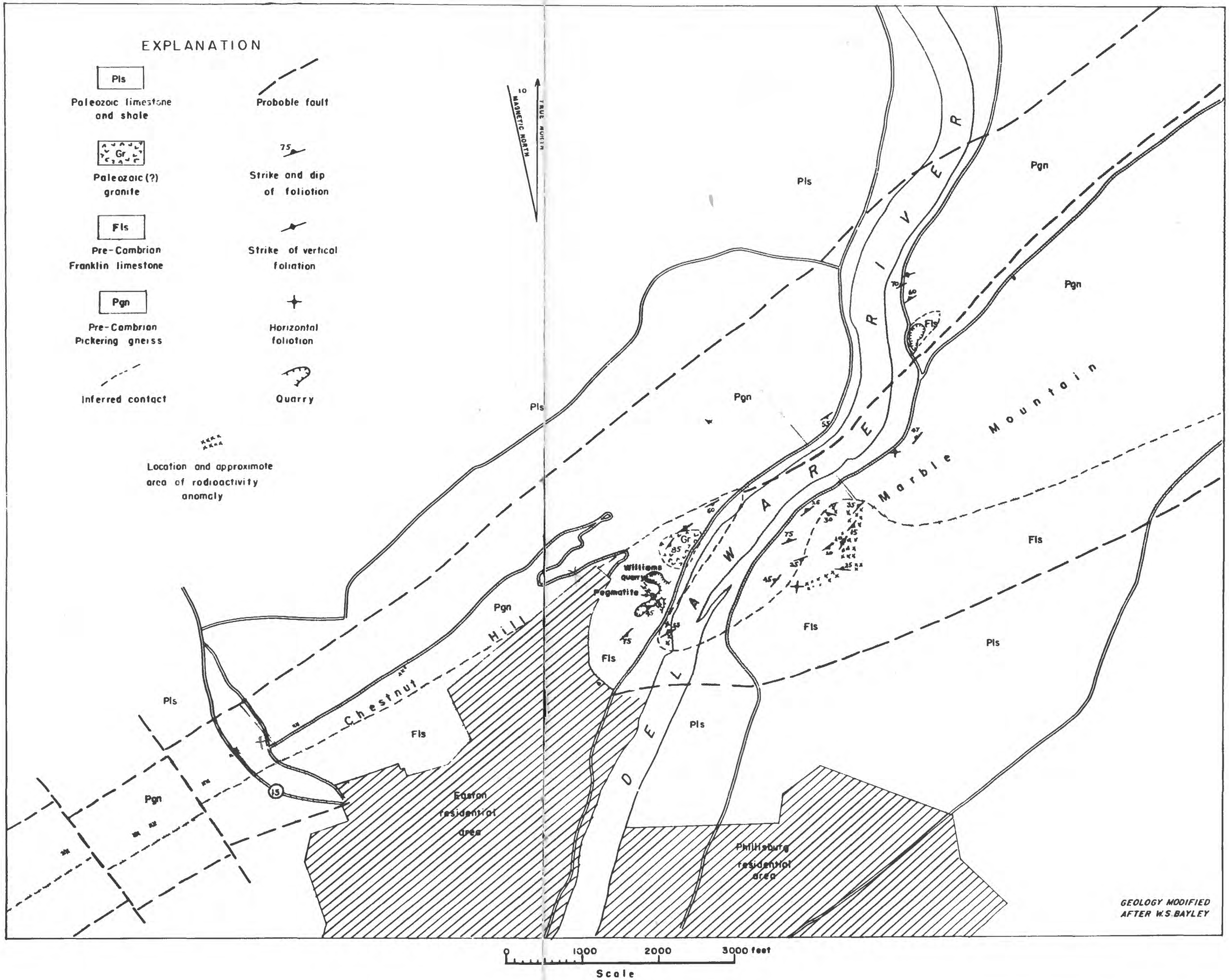

Fig. 6—Sketch map showing geology and location of radioactivity anomalies, Chestnut Hill-Marble Mountain Area.